City of Grants Pass
Stormwater Management Manual

July 19, 2007 (Final Draft)

GRANTS PASS
STORMWATER MANAGEMENT MANUAL
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Appendices

Chapter 1.0
GENERAL REQUIREMENTS & POLICIES

Summary of Chapter 1.0

This chapter outlines the City of Grants Pass's stormwater management requirements and identifies who is required to conform to them. It includes:

1.1 PURPOSE AND APPLICABILITY OF MANUAL

1.1.1 Purpose of Manual

Managing stormwater is a key element in maintaining and enhancing the City's livability. As the City develops, the impervious surfaces that are created increase the amount of runoff during rainfall events, disrupting the natural hydrologic cycle. Without controls, these conditions can cause erosion, flooding, and prevent groundwater recharge. In addition, parking lots, roadways, rooftops, and other impervious surfaces increase the pollution levels and temperature of stormwater runoff that is transported to streams, the Rogue River, and groundwater resources. Protecting these waters is vital for a great number of reasons, including fish and wildlife habitat, human health, recreation, and drinking water.

The purpose of this *Stormwater Management Manual* is to provide stormwater management principles and techniques that help preserve or mimic the natural hydrologic cycle, minimize storm drainage system problems, and achieve water quality goals. The manual provides developers and design professionals with specific requirements for reducing the impacts of increased stormwater runoff flow rate, quantity, and pollution resulting from new development and redevelopment.

1.1.2 Applicability of Manual

This manual's requirements apply to all projects under the jurisdiction of the City of Grants Pass, whether public or private.

- All projects creating or redeveloping 500 square feet or more of impervious surface, or existing properties proposing new stormwater discharges off-site, are required to comply with stormwater requirements presented in this manual.

- Users of this manual have the option of using the "simplified" approach or the more traditional methods of sizing stormwater management facilities. These traditional methods are defined as the "presumptive" approach and the "performance" approach within this manual. All designs must be sized in accordance with one of these methods and approved by the city.

1.2 SUMMARY OF MANUAL CONTENTS

Chapter 1.0: General Requirements & Policies, outlines the purpose and applicability of this manual and defines terms. It outlines pollution reduction and flow control explains the rules for connecting to existing systems, and differentiates public and private stormwater management systems. This chapter also discusses the City's policies regarding the protection of open drainageways. Finally, it identifies special circumstances that may make it impractical to implement on-site pollution reduction or flow control to the standards specified in this manual, and provides requirements to meet stormwater objectives in alternative ways.

Chapter 2.0: Stormwater Management Facility Design, provides methods for selecting and designing stormwater management facilities that accomplish pollution reduction, flow control, and/or destination/disposal standards. The "simplified," "presumptive," and "performance" approaches are presented.

Chapter 3.0: Operations & Maintenance, presents operations and maintenance (O&M) requirements and provides templates for stormwater management facility O&M plans.

Appendix A: Development Code Chapter 28.090, contains the section of Development Code that includes stormwater management policies and standards that officially recognizes the City's *Stormwater Management Manual*.

Appendix B: Santa Barbara Urban Hydrograph Method, describes the Santa Barbara Urban Hydrograph method of computing stormwater runoff hydrographs. It includes the City's 24-hour rainfall depths, formulas for computing time of concentration, and runoff curve numbers.

Appendix C: Simplified Approach Sizing Calculations, provides a sample of the method used to calculate the simplified approach sizing factors.

Appendix D: Facility Planting & Soil Recommendations, presents recommended plant species, soil, and design information for landscaped stormwater management facilities.

Appendix E: Supplemental Reference Materials, includes Intensity Duration Frequency curves, rainfall data, and other reference materials.

Other Available Resources (On the City's Website or on CD)

Supplemental Drawings, includes color cross-section and plan view drawings of many stormwater management facilities, as well as example planting plans.

Stormwater Facility Photos, provides a number of stormwater management facility photos, with site addresses.

1.3 DEFINITIONS

Note: All definitions are used in this manual and are intended to be consistent with Article 28.090 of the City Code. Some references to specific chapters or sections are included to assist the user in manual navigation.

Above-Ground Storage of Liquid Materials: Places where exterior storage (either permanent or temporary) of liquid chemicals, food products, waste oils, solvents, or petroleum products in above-ground containers, in quantities of 50 gallons or more exist.

***Aboveground Storage Tank (AST)*:** A stationary container, vessel, or other permanent holding device designated for the storage and/or distribution of a liquid product.

Applicant: Any person, company, or agency that applies for a permit through the City of Grants Pass.

Approved Receiving System (Destination): Any system approved by City Engineering to receive stormwater runoff or other discharges. Receiving systems include, but are not limited to, groundwater; on-site, off-site, or public stormwater systems; and waters of the state.

Bioretention Facility: A facility that utilizes soils and both woody and herbaceous plants to remove pollutants from stormwater runoff. Examples of bioretention facilities in this manual can include vegetated swales, flow-through and infiltration planters, vegetated filters, and vegetated infiltration basins.

***Bulk Fuel Terminal*:** Any area with its primary function dedicated to the storage and distribution of fuel to distributors (such as gas stations).

***Bulk Materials*:** Non-containerized materials.

***Bulk Material Transportation Route*:** Any path routinely used to transport materials onto, off of, or within a site.

Capacity: The capacity of a stormwater drainage system is the flow volume or rate that a facility (e.g., pipe, pond, vault, swale, ditch, drywell, etc.) is designed to safely contain, receive, convey, reduce pollutants from or infiltrate stormwater to meet a specific performance standard.

Catch Basin: A structural facility located just below the ground surface, used to collect stormwater runoff for conveyance purposes. Generally located in streets and parking lots, catch basins have grated lids, allowing stormwater from the surface to pass through for collection. Catch basins also include a sumped bottom and submerged outlet pipe (downturned 90 degree elbow, hood, or baffle board) to trap coarse sediment and oils.

Constructed Treatment Wetlands: A wetland-like facility designed and constructed for the specific purpose of providing stormwater management. Unlike natural wetlands (see definition), constructed treatment wetlands are not regulated by the Corps of Engineers or the Department of State Lands. See **Chapter 2.0** for information regarding the design of constructed treatment wetlands.

Contained Planter: A structural facility filled with topsoil and planted with vegetation. When placed over impervious surfaces such as sidewalks or flat rooftops, contained planters intercept rainfall that would otherwise contribute to stormwater runoff. See **Chapter 2.0** for information regarding the design of contained planters.

***Containerized*:** The storage of any product, by-product, or waste that is completely held or included on all sides, within a discrete volume or area.

***Containment*:** The temporary storage of potentially contaminated stormwater or process wastewater when a City sanitary sewer is not available for appropriate discharge.

Control Structure: A device used to hold back or direct a calculated amount of stormwater to or from a stormwater management facility. Typical control structures include vaults or manholes fitted with baffles, weirs, or orifices. See **Chapter 2.0** for information regarding the design of control structures.

Conveyance: The transport of stormwater or wastewater from one point to another.

Covered Vehicle Parking Areas: Covered vehicle parking structures used to cover parked vehicles other than single-level covers, such as canopies, overhangs, and carports.

DEQ: The Oregon Department of Environmental Quality.

Destination: The ultimate discharge point for the stormwater from a particular site, also known as the stormwater disposal point. Destinations can include on-site infiltration (surface infiltration facilities, and soakage trenches) and off-site flow to ditches, drainageways, rivers and streams, off-site storm pipes.

Detention Facility: A facility designed to receive and hold stormwater and release it at a slower rate, usually over a number of hours. The full volume of stormwater that enters the facility is eventually released.

Detention Tank, Vault, or Oversized Pipe: A structural subsurface facility used to provide flow control for a particular drainage basin. See **Chapter 2.0** for information regarding the design of detention tanks, vaults, and oversized pipes.

Development: Any human-induced change to improved or unimproved real estate, whether public or private, for which a permit is required, including but not limited to construction, installation, or expansion of a building or other structure, land division,

street construction, drilling, and site alteration such as dredging, grading, paving, parking or storage facilities, excavation, filling, or clearing. Development encompasses both new development and redevelopment.

Development Footprint: The new or redeveloped area covered by buildings or other roof structures and other impervious surface areas, such as roads, parking lots, and sidewalks.

Drainage Basin: A specific area that contributes stormwater runoff to a particular point of interest, such as a stormwater management facility, drainageway, wetland, river, or pipe.

Drainage Reserve: A dedicated tract of land that encompasses a drainageway.

Drainageway: An open linear depression, whether constructed or natural, which functions for the collection and drainage of surface water. It may be permanently or temporarily inundated.

Driveway**:** The area that provides vehicular access to a site. A driveway begins at the property line and extends into the site. In parking areas, the driveway does not include vehicular parking, maneuvering, or circulation areas.

Dry Detention Pond: A surface vegetated basin used to provide flow control for a particular drainage basin. Stormwater temporarily fills the dry detention pond during large storm events and is slowly released over a number of hours, reducing peak flow rates. See **Chapter 2.0** for information regarding the design of dry detention ponds.

Drywell: A structural subsurface cylinder or vault with perforated sides and/or bottom, used to infiltrate stormwater into the ground. Drywells are not an accepted treatment method within the City.

Equipment and/or Vehicle Washing Facilities: Designated equipment and/or vehicle washing or steam cleaning areas. This includes smaller activity areas such as wheel washing stations.

Extended Wet Detention Pond: A surface vegetated basin with a permanent pool of water and additional storage volume, used to provide pollution reduction and flow control for a particular drainage basin. The permanent pool of water provides a storage volume for pollutants to settle out. During large storm events, stormwater temporarily fills the additional storage volume and is slowly released over a number of hours, reducing peak flow rates. See **Chapter 2.0** for information regarding the design of extended wet detention ponds.

Exterior Materials Storage Area**:** Any outdoor materials storage location that is not completely enclosed by a roof and sidewalls.

Exterior Storage of Bulk Materials: Outdoor areas used to stockpile erodible materials.

Flow Control: The practice of limiting the release of peak flow rates and volumes from a site. Flow control is intended to protect downstream properties, infrastructure, and natural resources from the increased stormwater runoff peak flow rates and volumes resulting from development.

Flow Control Facility: Any structure or drainage device that is designed, constructed, and maintained to collect, retain, infiltrate, or detain surface water runoff during and after a storm event for the purpose of controlling post-development flow rate leaving the site.

Flow-Through Planter: A structural facility filled with topsoil and gravel and planted with vegetation. The planter is completely sealed, and a perforated collection pipe is placed under the soil and gravel, along with an overflow provision, and directed to an acceptable destination point. The stormwater planter receives runoff from impervious surfaces, which is filtered and retained for a period of time. See **Chapter 2.0** for information regarding the design of flow-through planters.

Fuel Dispensing Facilities: Areas where fuel is transferred from bulk storage tanks to vehicles, equipment, and/or mobile containers (including fuel islands, above ground fuel tanks, fuel pumps, and the surrounding pad). This definition applies to large-sized gas stations as well as single-pump fueling operations.

Grassy Swale (or Bioswale): A long and narrow, trapezoidal or semicircular-shaped channel, planted with a dense grass mix. Stormwater runoff from impervious surfaces is directed through the swale, where it is slowed and in some cases infiltrated, allowing pollutants to settle and filter out. See **Chapter 2.0** for information regarding the design of grassy swales.

***Hazardous Material*:** Any material or combination of materials that, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness; or that may pose a present or potential hazard to human health, safety, or welfare, or to animal or aquatic life or the environment when improperly used, stored, transported or disposed of, or otherwise managed. For purposes of chemical regulation by this manual, moderate to high toxicity and confirmed human carcinogenicity are the criteria used to identify hazardous substances. (Note: This manual does not use the Resource Conservation and Recovery Act (RCRA) definition of hazardous. For the purpose of this manual, hazardous material is intended to include hazardous, toxic, and other harmful substances.)

***Hazardous Material Containment Zone (HMC Zone)*:** An area where a specific individual activity involving use of a hazardous material takes place, and where chemical quantities at that location are expected to exceed defined thresholds. HMCs

may include (but are not limited to) storage and/or process areas, transportation routes, work areas, and loading/unloading facilities.

High-Risk Site: A site with characteristics and/or activities that have the potential to generate pollutants that may not be addressed solely through the pollution reduction facilities presented in Chapter 2.0.

Impervious Surface Area (ISA): Any surface that has a runoff coefficient greater than 0.8. Types of impervious surface include rooftops, traditional asphalt and concrete parking lots, driveways, roads, sidewalks, and pedestrian plazas. *Note:* Slatted decks are considered pervious. Gravel surfaces are considered pervious unless they cover impervious surfaces or are compacted to a degree that causes their runoff coefficient to exceed 0.8.

Infiltration: The percolation of water into the ground.

Infiltration Planter: A structural facility filled with topsoil and gravel and planted with vegetation. The planter has on open bottom, allowing water to infiltrate into the ground. Stormwater runoff from impervious surfaces is directed into the planter, where it is filtered and infiltrated into the surrounding soil. See **Chapter 2.0** for information regarding the design of infiltration planters.

Inlet: A structure located just below the ground surface, used to collect stormwater runoff. Generally located in streets and parking lots, inlets have grated lids, allowing stormwater from the surface to pass through for collection. The term "inlet" is also used in reference to the point at which stormwater from impervious surfaces or conveyance piping enters a stormwater management facility.

Landscaping: See definition of *Stormwater Facility Landscaping*.

***LD-50*:** The lethal dose of a substance that is expected to kill approximately 50 percent of experimental animals through oral ingestion. (Refer to product Material Safety Data Sheet.)

***Local Dispensing Location*:** An area within 15 feet of an aboveground storage tank (AST) and used to dispense fuel directly from the AST, typically through a flexible hose.

Manufactured Stormwater Treatment Technology: A proprietary structural facility or device used to remove pollutants from stormwater.

Material Transfer Areas/Loading Docks: Areas designed to accommodate a truck/trailer being backed up to or into them, and used specifically to receive or distribute materials to and/or from trucks/trailers. Includes loading/unloading facilities with docks, and large bay doors without docks.

Maximum Extent Practicable (MEP): See definition of *Practicable*. A term used in the Clean Water Act.

Off-site stormwater facility: Any stormwater management facility located outside the property boundaries of a specific development, but designed to provide stormwater management benefits for that development.

On-site stormwater facility: Any stormwater management facility located within the property boundaries of a specific development, and designed to provide stormwater management benefits for that development.

Open Channel: A fluid passageway that allows part of the fluid to be exposed to the atmosphere.

Operations and Maintenance (O&M): The continuing activities required to keep stormwater management facilities and their components functioning in accordance with design objectives. See **Chapter 3.0** regarding operations and maintenance requirements for stormwater management facilities.

Outfall: A location where collected and concentrated water is discharged. Outfalls can include discharge from stormwater management facilities, drainage pipe systems, and constructed open channels. See **Chapter 2.0** for information regarding the design of outfalls.

Parking Area**:** The area of a site devoted to the temporary or permanent storage, maneuvering, or circulation of motor vehicles. Parking areas do not include driveways or areas devoted exclusively to non-passenger loading.

Permeable Pavement: See definition of *Pervious Pavement*.

Pervious Pavement: The numerous types of pavement systems that allow stormwater to percolate through them and into subsurface drainage systems or the ground. See **Chapter 2.0** for design requirements related to pervious pavement. Also referred to as porous or permeable pavement.

Pollutant: An elemental or physical material that can be mobilized or dissolved by water or air and creates a negative impact to human health and/ or the environment. Pollutants include suspended solids (sediment), heavy metals (such as lead, copper, zinc, and cadmium), nutrients (such as nitrogen and phosphorus), bacteria and viruses, organics (such as oil, grease, hydrocarbons, pesticides, and fertilizers), floatable debris, and increased temperature.

Pollutants of Concern: Watershed-specific pollutants identified by the Oregon Department of Environmental Quality (DEQ) within the 303(d) list or as established TMDLs that are of concern within a specific watershed. These pollutants have been identified as over a healthy threshold for the watershed and additional discharge would

have a negative impact on the receiving water body. Pollutants of concern can include suspended solids, heavy metals, nutrients, bacteria and viruses, organics, floatable debris, and increased temperature.

Pollution Reduction: The practice of filtering, retaining, or detaining surface water runoff during and after a storm event for the purpose of maintaining or improving surface and/or groundwater quality.

Pollution Reduction Facility: A structure, landscape, or drainage device that is designed, constructed, and maintained to collect and filter, retain, or detain surface water runoff during and after a storm event for the purpose of maintaining or improving surface and/or groundwater quality.

Porous Pavement: See definition of *Pervious Pavement*.

Post-Developed Condition: As related to new or redevelopment: A site's ground cover and grading after development.

Practicable: Available and capable of being done as determined by the City Engineer, after taking into consideration cost, existing technology, and logistics in light of overall project purpose.

Pre-Developed Condition: As related to new development: A site's ground cover and grading prior to development. As related to redevelopment it is the condition of the land prior to any new construction.

Public Facility: A street, right-of-way, sewer, drainage, stormwater management, or other facility that is either currently owned by the City or will be conveyed to the City for maintenance responsibility after construction. The city shall require that a new stormwater management facility that receives direct stormwater runoff from a public right-of-way to be a public (City-maintained) facility meeting all applicable requirements unless the right-of-way is not part of the City's road maintenance system.

Public Works Project: Any development (excluding public buildings) conducted or financed by a local, state, or federal governmental body, including local improvements and public improvements, as defined in the Grants Pass City Code.

Redevelopment: Any development that requires demolition or complete removal of existing structures or impervious surfaces at a site and replacement with new impervious surfaces. Maintenance activities such as top-layer grinding, re-paving, and re-roofing are not considered to be redevelopment. Interior remodeling projects and tenant improvements are also not considered to be redevelopment.

Retention Facility: A facility designed to receive and hold stormwater runoff. Rather than storing and releasing the entire runoff volume, retention facilities permanently retain a portion of the water on-site, where it infiltrates, evaporates, or is absorbed by

surrounding vegetation. In this way, the full volume of stormwater that enters the facility is not released off-site.

***Roadway*:** Any paved surface used to carry vehicular traffic (cars/trucks, forklifts, farm machinery, or any other large machinery).

Roof Garden: A heavyweight roof system of waterproofing material with a thick soil and vegetation cover. Roof gardens provide stormwater management by capturing, filtering, and evaporating rainfall. See **Chapter 2.0** for information regarding the design of roof gardens.

Runoff: Stormwater flows across the ground surface during and after a rainfall event. Also simply referred to as stormwater.

Sand Filter: A structural facility with a layer of sand, used to filter pollutants from stormwater. Sand Filters are not an accepted treatment method within the City.

Santa Barbara Urban Hydrograph (SBUH): A hydrologic method used to calculate runoff hydrographs. See **Appendix B** for information regarding the use of the Santa Barbara Urban Hydrograph method.

Soakage Trench: A linear excavation backfilled with sand and gravel, used to filter pollutants and infiltrate stormwater. See **Chapter 2.0** for information regarding the design of soakage trenches.

Solid Waste Storage Areas, Containers, and Trash Compactors: Outdoor areas with one or more facilities that store solid waste (both food and non-food waste) excluding single-family residential sites.

Stormwater: Water runoff that originates as precipitation on a particular site, basin, or watershed. Also referred to as runoff.

Stormwater Facility Landscaping: The vegetation (plantings), topsoil, rocks, and other surface elements associated with stormwater management facility design. See **Chapter 2.0** for stormwater facility landscaping requirements.

Stormwater Management: The overall culmination of techniques used to reduce pollutants from, detain and/or retain, and provide a destination for stormwater to best preserve or mimic the natural hydrologic cycle, to accomplish goals of reducing flooding, or to fit within the capacity of existing infrastructure.

Stormwater Management Facility: A feature used to reduce pollutants from, detain and/or retain, or provide a destination for stormwater to best preserve or mimic the natural hydrologic cycle, to accomplish goals of reducing flooding, or to fit within or improve the capacity of existing infrastructure.

Stormwater Re-use: See definition of *Rainwater Harvesting*.

Street Swale: A vegetated or grassy swale (or bioswale) located next to a public or private street for the purpose of managing stormwater. See **Chapter 2.0** for information regarding the design of street swales.

Sump: A large public drywell (see definition) used to infiltrate stormwater from public streets. Sumps are generally 48 inches in diameter and 30 feet deep. The term "sump" is also used to reference to any volume of a facility below the point of outlet, in which water can accumulate. Sumps are considered UICs and are not an accepted treatment method within the City.

Surface Conveyance: The transport of stormwater on the ground surface from one point to another.

Surface Infiltration Facility: A facility designed to receive and infiltrate stormwater runoff at the ground surface to meet stormwater destination/ disposal requirements. Pollution reduction and flow control requirements can also be met with surface infiltration facilities.

Surface Retention Facility: A facility designed to receive and hold stormwater runoff at the ground surface. Rather than storing and releasing the entire runoff volume, surface retention facilities permanently retain a portion of the water on-site, where it infiltrates, evaporates, or is absorbed by surrounding vegetation.

Tenant Improvements: Structural upgrades made to the interior or exterior of buildings.

Time of Concentration (T of C): The amount of time it takes stormwater runoff to travel from the most distant point (measured by travel time) on a particular site or drainage basin to a particular point of interest. See **Appendix C** for calculations related to time of concentration.

Total Suspended Solids (TSS): A measure of the amount of small, particulate solid pollutants that are suspended in wastewater.

Underground Injection Control (UIC): UIC systems are defined as any system, structure, or activity that is created to place fluid below the ground or subsurface. The most common stormwater UIC systems or activities in Oregon include sumps, drywells, trench drains, and drill holes. These systems are regulated by the 1974 Federal Safe Drinking Water Act to protect the nation's drinking water resources. In Oregon all groundwater is considered a drinking water resource and UIC systems are administered by the Oregon Department of Environmental Quality (DEQ). UICs are not an accepted treatment method within the City of Grants Pass.

Vegetated Facilities: Stormwater management facilities that rely on plantings to enhance their performance. Plantings can provide wildlife habitat and enhance many

facility functions, including infiltration, pollutant removal, water cooling, flow calming, and prevention of erosion.

Vegetated Filter: A gently sloping, densely vegetated area used to filter, slow, and infiltrate stormwater. See **Chapter 2.0** for information regarding the design of vegetated filters.

Vegetated Infiltration Basin: A vegetated facility that temporarily holds and infiltrates stormwater into the ground. See **Chapter 2.0** for information regarding the design of vegetated infiltration basins.

Vegetated Swale: A long and narrow, trapezoidal or semicircular channel, planted with a variety of trees, shrubs, and grasses. Stormwater runoff from impervious surfaces is directed through the swale, where it is slowed and in some cases infiltrated, allowing pollutants to settle out. Check dams are used to create small ponded areas to facilitate infiltration. See **Chapter 2.0** for information regarding the design of vegetated swales.

Water Body: Water bodies include coastal waters, rivers, sloughs, continuous and intermittent streams and seeps, ponds, lakes, aquifers, and wetlands.

Water Quality: A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Watercourse: A channel in which a flow of water occurs, either continuously or intermittently, with some degree of regularity. Watercourses may be either natural or artificial.

Wet Pond: A vegetated basin with a permanent pool of water, used to provide pollution reduction for a particular drainage basin. The permanent pool of water provides a storage volume for pollutants to settle out. See **Chapter 2.0** for information regarding the design of wet ponds.

Wetland: An area that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands include swamps, marshes, bogs, and similar areas except those constructed as pollution reduction or flow control facilities. Specific wetland designations shall be made by the Corps of Engineers and the Department of State Lands.

1.4 STORMWATER DESTINATION/DISPOSAL

1.4.1 The Purpose of Stormwater Destination/Disposal

Stormwater destination or disposal refers to the ultimate discharge point for stormwater generated by large, intense rainfall events from a particular development site. Destinations can be grouped into two general categories: on-site infiltration and off-site flow. On-site infiltration methods include surface infiltration techniques. Off-site flow methods include discharge to drainageways (including roadside ditches and natural drainages and streams), rivers, and off-site storm sewers. The appropriate destination or disposal point is site-specific and depends on a number of factors, including soil type, slopes, and availability of public and private infrastructure.

1.4.2 Destination/Disposal Standards

ON-SITE INFILTRATION

Where on-site infiltration is used for the destination/disposal of stormwater, the following standards shall apply:

> **Surface Infiltration Facilities (public or private):** Surface infiltration facilities must demonstrate the ability to store and infiltrate the 10-year, 24-hour storm. See **Section 2.2.2** for detailed surface infiltration facility sizing and design procedures, including safety factors.

OFF-SITE DISCHARGE TO SURFACE FLOW

Where stormwater is discharged to an off-site surface flow conveyance facility, such as a ditch, drainageway, stream, or river, the following standards shall apply:

> Beginning at the point of discharge from the site, all on-site surface conveyance facilities must have the capacity to convey flows from the 25-year, 24-hour storm from all contributing upstream drainage areas. The 25-year storm flow rate shall be calculated using approved hydrologic modeling methods outlined in Chapter 2 of this manual.

OFF-SITE DISCHARGE TO PIPED FLOW

Where stormwater is discharged to an off-site piped conveyance facility, the following standards shall apply:

One point of discharge into existing City system: Unless approved by the City Engineer there will only be one point of discharge per drainage basin for each development. Developed conditions should match the discharge points of the current conditions discharge points.

For new development or redevelopment with an increase in net impervious area: Beginning at the point of discharge from the site, the piped conveyance facility must have the capacity to convey flows from the 10-year storm from all contributing upstream drainage areas without surcharge. The piped conveyance facility may surcharge during the 25-year storm, but the hydraulic grade line must remain 2-feet lower than the manhole rim elevation. The 10- and 25-year storm flow rates shall be calculated using approved hydrologic modeling methods outlined in Chapter 2 of this manual.

For redevelopment with no net increase in impervious area: Existing downstream pipe conveyance facilities may be allowed to surcharge under certain circumstances with approval from the City Engineer.

100-YEAR ESCAPE ROUTE

All projects must demonstrate where stormwater from the 100-year storm event will go, and that public safety concerns and property damage will be avoided. This may include storage in parking lot, street, or landscaping areas but should not adversely change conditions on off-site properties.

1.5 POLLUTION REDUCTION

1.5.1 The Purpose of Pollution Reduction

Urbanization is recognized as having a serious impact on Grants Pass's waters. As land is developed, impervious area and surface runoff increase. This runoff collects and transports pollutants to downstream receiving waters and the City stormwater system.

General pollutants of concern include:

- Suspended solids (sediment)
- Heavy metals (dissolved and particulate, such as lead, copper, zinc, and cadmium)
- Nutrients (such as nitrogen and phosphorus)
- Bacteria and viruses
- Organics (such as oil, grease, hydrocarbons, pesticides, and fertilizers)
- Floatable debris
- Increased thermal load (temperature)

In response to the water quality impacts of urbanization, Congress passed the Clean Water Act amendments of 1987, mandating the U.S. Environmental Protection Agency (EPA) issue regulations to control urban stormwater pollution. Regulations published in 1990, require larger cities ("Phase I") to obtain a National Pollutant Discharge Elimination System (NPDES) stormwater discharge permit for their municipal separate storm sewer discharges. Additional regulations, promulgated in 1999, require smaller communities (regulated small MS4s) to implement programs and practices to control polluted stormwater runoff, through the NPDES permit program.

It is anticipated that Grants Pass will be required to meet the NPDES requirements in the future. This manual was developed to address these requirements.

Grants Pass's citywide stormwater management program includes design standards for source control devices as well as best management practices designed to improve stormwater quality.

1.5.2 Pollution Reduction Requirements

The City of Grants Pass has a citywide pollution reduction requirement for all development and redevelopment projects creating 500 square feet or more of impervious surface area. This requirement is summarized as follows:

- 70 percent removal of total suspended solids is required for the Water Quality storm defined as 1-inch over 24 hours.
- Projects will also need to address pollutants established as total maximum daily loads (TMDLs) from Oregon DEQ and must select and use a pollution reduction facility that is capable of reducing the pollutants of concern, as approved by the City Engineer.

Rainfall intensity needed to treat 90% of the average annual runoff in Grants Pass	
Site's Time of Concentration (Minutes)	**Rainfall Intensity (Inches per Hour)**
5	0.19
10	0.16
20	0.13

If the rational method (Q=CIA) is approved for use by the City Engineer under conditions in Chapter 2, the above rainfall intensities are to be used to calculate pollution reduction runoff rates. These flow rates are used to size rate-based pollution reduction facilities unless the **Simplified Approach** from Chapter 2.0 is used.

Exhibit 1-2: Pollution Reduction Facility Removal Capabilities For TMDL Parameters

The facility can likely remove or preclude the parameter.
The facility can potentially remove or prevent the parameter, depending on design.
The facility cannot likely remove or prevent the parameter.

Pollution Reduction or Prevention Facility	Bacteria	Temperature	Nutrients	Pesticides (DDT, Dieldrin, Aldrin)	PCB	2,3,7,8 TCDD (Dioxin)	PAH	Trace Metals (Pb, As, Fe, Mn)
Roof garden								
Pervious pavement								
Tree credit								
Contained planter								
Rainwater Harvesting								
Infiltration planter								
Flow-through planter								
Vegetated swale								
Grassy swale								
Street swale								
Vegetated filter								
Vegetated infiltration basin								
Wet pond								
Extended wet detention pond								
Constructed treatment wetland								
Sand filter								
Manufactured filtration device								

Note: This table is based on limited information and should be used for guidance only. Actual pollutant reduction and prevention capabilities are based on specific facility design and site conditions.

1.5.3 Pollution Reduction Oil Control for Vehicle and Equipment Traffic Areas

Vehicle and equipment traffic areas are required to incorporate oil controls into the stormwater management design if they have the following characteristics:

- Commercial or industrial parking lots that store wrecked or impounded vehicles.
- Areas with a high likelihood of oil and grease loadings, such as fast-food restaurant drive-thru and parking, grocery and convenience store parking, vehicle repair, vehicle sales, and vehicle fueling services.

Oil controls can include spill control manholes (**Exhibit 2-26**) or the incorporation of Lynch-type catch basins within the parking lot or at the outlet to swales or other pollution reduction facilities. The discharge of stormwater with a visible sheen off-site is prohibited. Vehicle and equipment traffic areas that trigger these requirements must be paved with an impervious material. Because gasoline can react with asphalt pavement, it is preferable to pave the areas with concrete.

1.5.4 Pollution Reduction Exemption for Rooftops that Infiltrate On-Site

Projects that infiltrate rooftop stormwater runoff with private soakage trenches or surface infiltration facilities are not required to provide pollution reduction prior to infiltration. This exemption does not apply to projects that discharge stormwater off-site.

1.6 FLOW CONTROL

1.6.1 The Purpose of Flow Control

Prior to development, runoff appears as streamflow, evaporates into the atmosphere, or infiltrates into the ground where it recharges groundwater aquifers or surface water bodies. Urbanization results in the loss of forest, agricultural land, and open space and increases the amount of impervious area. As a result, development can have the following hydrologic impacts:

- Increased stormwater flow rates
- Increased stormwater runoff volumes
- Decreased groundwater recharge and base flows into streams
- Seasonal flow volume shifts

Flow control is intended to protect downstream properties, infrastructure, and natural resources from the increases in stormwater runoff peak flow rates and volumes resulting from development.

The City's policy is to ensure that runoff leaving the post-development site:

- Does not exceed the capacity of the receiving conveyance facility or water body.
- Does not increase the potential for stream bank and stream channel erosion.
- Does not create or increase any upstream or downstream flooding problems.

The basic design concept for flow control (detention and retention) is simple: water from developed areas is managed with a variety of flow control techniques and released to downstream conveyance systems at a slower rate (detention) and lower volume (retention). Managing flows in this way attempts to mimic the site's natural rainfall runoff response prior to development (see **Exhibit 1-3**).

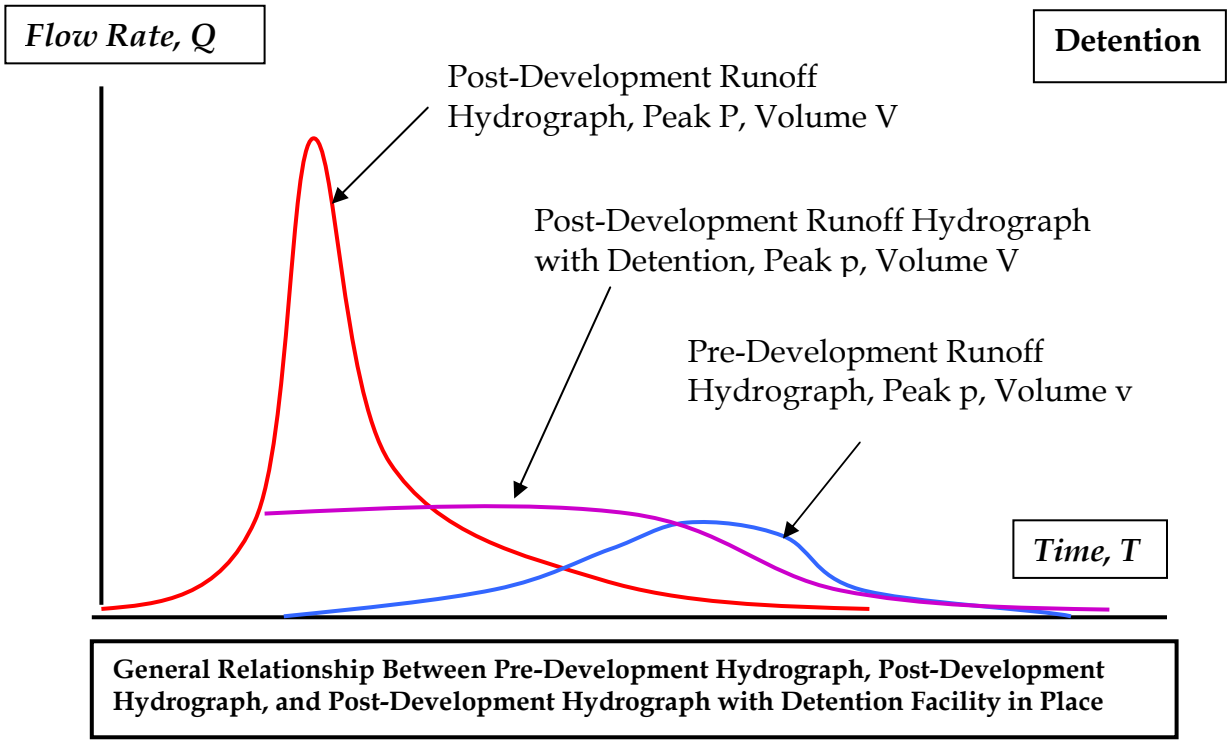
Detention facilities, such as ponds, tanks, vaults, or oversized pipes temporarily store stormwater runoff. The water is slowly released from the facility, typically over a number of hours.

Retention facilities also store stormwater runoff. Rather than storing and releasing the entire runoff volume, however, the facility permanently retains a portion of the water on-site, where it infiltrates and recharges the groundwater aquifer, and in the case of surface retention facilities, evaporates or is absorbed and used by surrounding vegetation. In this way, retention facilities reduce the total volume of water released downstream. Examples of retention facilities include surface treatments (such as eco-roofs or pervious pavements) that cover or replace traditional impervious surfaces and vegetated facilities such as swales, filters, ponds, and planter boxes.

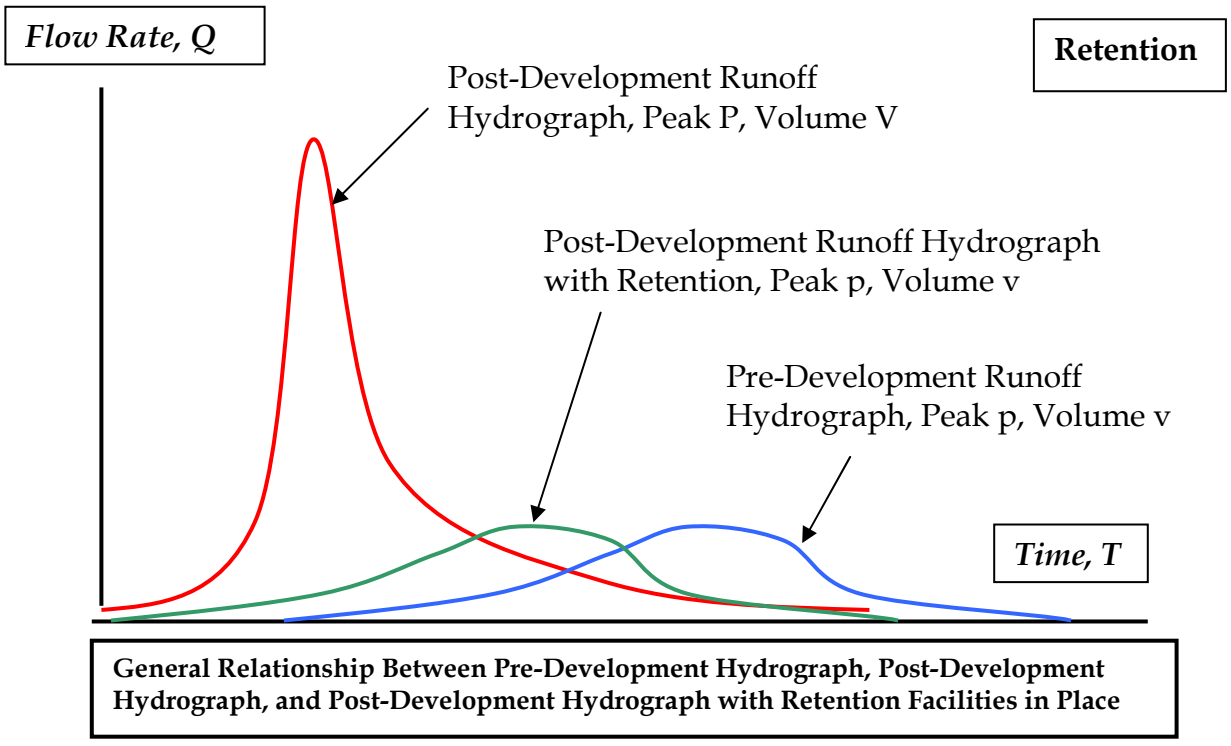
In the past, flow control plans often relied solely on detention facilities. Facilities that control only peak flow rates, however, allow the duration of high flows to increase, causing the potential for increased erosion downstream. For example, after development with detention, the magnitude of the 2-year peak flow rate may not increase, but the amount of time (duration) that the flow rate occurs will increase, and the frequency that the 2-year peak flow rate occurs will also increase. Retention systems, on the other hand, are particularly effective at lowering the overall runoff volume, reducing the amount of time (duration) that the peak flow rate occurs, as well as the frequency. In addition, by infiltrating stormwater, retention systems recharge groundwater that serves as the base flow for streams during the dry season. Therefore, stream systems that require erosion protection, including salmonid habitat streams, warrant the use of retention systems. Where retention systems cannot be used, detention systems that control the duration of the geomorphically significant flow (i.e., flow capable of moving sediment) shall be used. Such detention systems employ lower release rates and are therefore larger in volume.

Time of concentration (the time it takes rainfall to accumulate and run off a site) is another important factor in determining downstream hydrologic impacts created by development. Flow rates from individual sites may be controlled, but when they are combined quickly in fast-flowing conveyance pipes, the downstream effect will still be increased in-stream flow rates and volumes. Breaking flow patterns up into surface retention systems helps increase a site's time of concentration and lessens downstream impacts.

Exhibit 1-3: The Effect of Detention and Retention Facilities on Post-Developed Hydrographs (Large Storm Events)



General Relationship Between Pre-Development Hydrograph, Post-Development Hydrograph, and Post-Development Hydrograph with Detention Facility in Place



General Relationship Between Pre-Development Hydrograph, Post-Development Hydrograph, and Post-Development Hydrograph with Retention Facilities in Place

1.6.2 Flow Control Requirements

On-site infiltration is required to the maximum extent practicable (as determined by city engineer per definition) to control stormwater volumes and flow rates. Where complete on-site infiltration is not practicable, other on-site retention techniques (such as pervious pavement, ecoroofs, planters, swales, and other surface vegetated facilities) are required to the maximum extent practicable to reduce runoff volumes, with the following exceptions:

- Space constraints prohibit the construction of on-site retention facilities. Required setbacks from buildings and property lines need to be considered for each facility type.
- The use of surface retention is not practicable or safe because of soil or slope conditions. The City Engineer may require an investigation and recommendation of a qualified geotechnical engineer or engineering geologist to demonstrate that this exception applies to a site. It should be noted that some surface retention facilities, such as flow-through planter boxes, are lined and therefore do not infiltrate stormwater into surrounding soils.
- Contaminated soils limit the use of retention approaches.
- Required source controls for high-risk sites conflict with the use of on-site retention facilities.

Where complete on-site infiltration or the use of retention facilities is not practicable, detention shall be required sufficient to maintain peak flow rates from the new impervious surfaces created at their pre-development levels for the 2-year and 25-year, 24-hour runoff events. Note that for redevelopment projects, pre-development condition is defined as the condition of the land prior to any new construction. (See definition of pre-developed condition in **Section 1.3**)

Because of minimum orifice size specifications, detention facilities that rely on orifice structures to control flows for small projects (under 15,000 square feet of impervious development footprint area) may not be effective.

Any development that discharges stormwater off-site that eventually flows to a tributary stream that shows evidence of excessive stream bank and channel erosion (as determined by the City Engineer) will have more restrictive flow control requirements to reduce the potential for further aggravation of instream erosion problems. This applies to all conveyances (streams, canals, road ditches, pipes) that discharge to tributaries within the Grants Pass area.

The added controls are based on the geomorphically significant flow, which is the flow that initiates sediment movement in the channels. The erosion-causing flow varies from channel to channel. Unless more specific data are available, the City assumes that the

erosion-causing flow is one-half of the 2-year, 24-hour pre-developed peak flow, and the requirements of this manual are based on that assumption. **Specifically, the more restrictive control requirement is to limit the 2-year, 24-hour post-development peak flow rate to the pre-development erosion-initiating rate (one-half of the 2-year, 24-hour flow rate). The facilities shall also control the post-development flows from the 5-, 10-, and 25-year, 24-hour peak flows to the pre-development 5-, 10-, and 25-year, 24-hour levels**.

1.7 OPEN DRAINAGEWAY POLICIES

A drainageway is an open linear depression, whether constructed or natural, that functions for the collection and drainage of surface water. It may be permanently or temporarily inundated. Drainageways provide many important functions to both the stormwater conveyance system and the environment.

Open drainageways provide both flow management (regulation of stream flow, retention and detention of water, flood control, contribution to seasonal base flows, and groundwater recharge) and water quality protection (filtration of pollutants and reduction of stormwater temperatures).

The City of Grants Pass protects open drainageways by requiring them to be placed in drainage reserves. Drainage reserve requirements may be imposed during land use reviews, building permit reviews, or other development processes that require City review. The requirement to place the drainage reserve in a dedicated tract may be imposed during partition or subdivision land use reviews only.

Storm drainage reserves shall remain in natural topographic condition, or in the case of man-made drainages such as street ditches, the topographic condition at the time of the proposed development. No private structures, culverts, excavations, or fills shall be constructed within drainage reserves unless authorized by the City Engineer.

Sizing of Drainageway Reserves: Drainage reserves shall be sized to assure that the current flow rate and pattern of the drainageway continues to be adequately conveyed through the development site. Current flow volumes and/or drainageway capacities will be determined by reviewing existing data, which may include available hydrologic records, drainage basin hydrology, historical data, high-water marks, soil inundation records, photographs of past flooding, and other similar information. Reserves shall be placed on a proposed development site in one of the following manners:

1) 15 feet from the centerline of the channel; or
2) 15 feet from the delineated edge of a designated water feature (i.e. seep, spring, wetland); or
3) Within the boundary of a designated environmental zone; or
4) Over a designated seep, spring, or stream tract.

Disturbances or Development within Drainage Reserves: Disturbances or development within the drainage reserve shall only be allowed when all of the following conditions exist:

1) The disturbance or development will not impede or reduce flows within the drainageway.
2) The disturbance or development will not cause detrimental impacts on habitat values or downstream water bodies for the migration, rearing, feeding, or spawning of fish.
3) Where the development involves a constructed crossing of the drainageway for vehicular or pedestrian access, there are no practicable alternatives with fewer impacts.
4) The development location, design, and construction method has the least significant detrimental impact to identified functional values of the drainageway of other practicable and different alternatives, including alternatives outside of the drainageway resource.

1.8 DISCHARGING TO EXISTING STORMWATER MANAGEMENT FACILITIES

The City of Grants Pass operates and maintains many stormwater management facilities. These facilities are designed to receive stormwater runoff from certain defined areas. A development may discharge to an existing **publicly** operated stormwater facility (see definition of public facility in **Section 1.3)** if all of the following criteria are met:

- The conveyance system and facility to which the development is discharging have capacity (see definition of capacity in **Section 1.3**).

- The stormwater management facility is adequately designed in accordance with the most recent version of the *Stormwater Management Manual*, and was designed to include the development area in question. This does not include simple conveyance facilities.

- The applicant shows that private on-site infiltration facilities are being used to the maximum extent practicable, unless a previous land-use review case approved the development without such measures.

1.9 EXTERIOR STORAGE OF BULK MATERIALS

1.9.1 Applicability

The requirements of this section apply to developments that stockpile or store materials in outdoor containers that may erode or have negative stormwater impacts. The materials are separated into three categories, based on risk assessments for each material stored: high-risk, low-risk, and exempt. These include, but are not limited to, the following general types of materials:

High-Risk Materials	Low-Risk Materials	Exempt Materials
• Recycling materials with potential effluent • Corrosive materials (e.g., lead-acid batteries) • Storage and processing of food items • Chalk/gypsum products • Feedstock/grain • Material by-products with potential effluent • Fertilizer • Pesticides • Lime/lye/soda ash • Animal/human wastes	• Recycling materials without potential effluent • Scrap or salvage goods • Metal • Sawdust/bark chips • Sand/dirt/soil (including contaminated soil piles) • Material by-products without potential effluent • Unwashed gravel/rock • Compost • Asphalt	• Washed gravel/rock • Finished lumber • Rubber and plastic products (hoses, gaskets, pipe, etc.) • Clean concrete products (blocks, pipe, etc.) • Glass products (new, non-recycled) • Inert products

Materials with any of the following characteristics are exempt from the requirements of this section:

- Have no measurable solubility or mobility in water and no hazardous, toxic, or flammable properties.

- Exist in a gaseous form at ambient temperature.

- Are contained in a manner that prevents contact with stormwater (excluding pesticides and fertilizers).

1.9.2 Requirements

1) COVER

Low-risk materials shall be covered with a temporary plastic film or sheeting at a minimum.

High-risk materials shall be permanently covered with a canopy or roof to prevent stormwater contact and minimize the quantity of rainfall entering the storage area. Runoff shall be directed from the cover to a stormwater disposal point that meets all applicable code requirements.

- **Covers 10 feet high or less** shall have a minimum overhang of 3 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated activity area.

    - **Covers higher than 10 feet** shall have a minimum overhang of 5 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated activity area.

2) PAVEMENT

Low-risk material storage areas are not required to be paved.

High-risk material storage areas shall be paved beneath the structural cover. Sizing of the paved area shall adequately cover the activity area intended for storage.

3) DRAINAGE

Low-risk material storage areas are typically allowed in areas served by standard stormwater management systems. However, all erodible materials being stored must be protected from rainfall.

If materials are erodible, a structural containment barrier shall be placed on at least three sides of every stockpile. The barrier shall be tall enough to prevent run-on of uncontaminated stormwater into the storage area and migration of the stored materials as a result of being blown or washed away. If the area under the stockpile is paved, the barrier can be constructed of asphalt berms, concrete curbing, or retaining walls. If the area under the stockpile is unpaved, sunken retaining walls or ecology blocks can be used. The applicant shall clearly identify the method of containment on the building plans.

For **high-risk** material storage areas, the paved area beneath the structural cover shall be hydraulically isolated through grading, structural containment berms or walls, or perimeter drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away. If the applicant elects to install drainage facilities, the drainage from the hydraulically isolated area shall be directed to an approved City sanitary sewer or authorized pretreatment facility.

4) ADDITIONAL REQUIREMENTS

A) *A **Source Control Installations Form** shall be submitted as part of the building permit application to facilitate tracking of containment, sampling manholes, and shut-off valve installations.*

B) **Storage of pesticides and fertilizers** may need to comply with specific regulations outlined by DEQ. For answers to technical questions please call the Oregon DEQ.

C) **A sampling manhole** or other suitable stormwater monitoring access point may be required to monitor stormwater runoff from the storage area. This may apply to certain types of storage activities and materials or if an alternative source control is proposed. This requirement complies with City Code Chapter 28.090, which requires appropriate stormwater disposal. The City Engineer will review for applicability of this requirement.

D) **Signage** shall be provided at the storage area if hazardous materials or other materials of concern are stored. Signage shall be located so it is plainly visible from all storage activity areas. More than one sign may be needed to accommodate large storage areas.

E) **A shut-off valve** may be required for the structurally covered storage area if the applicant elects to install drainage facilities to an approved City sanitary sewer. The City Engineer will make this determination based on the type of material stored and the proposed system receiving the discharge.

F) **Storage of hazardous materials** that are toxic, carcinogenic, or halogenated solvents (within designated groundwater protection areas) may be subject to additional requirements.

1.10 SPECIAL CIRCUMSTANCES

Special circumstances on a proposed site may make it impractical to implement on-site pollution reduction or flow control to the standards specified in this manual. Applicants who cite special circumstances shall submit **Form SC: Special Circumstances** (provided at the end of this section).

The City Engineer will determine if all or a portion of the stormwater management obligations may be fulfilled off-site. The applicant shall account for the management of all stormwater runoff from the site. If the City Engineer approves a special circumstances claim, the applicant must construct an appropriately sized off-site facility, or a fee must be paid to the City to construct off-site facilities. The fee will be pro-rated to account for portions of the stormwater management obligation met on-site (as determined by the City's review of proposed on-site facilities). The unit cost will be further divided into pollution reduction and flow control components to account for differences in the development's ability to satisfy each component on-site.

Source Controls. Some site characteristics and uses may generate specific pollutants of concern or levels of pollution that are not addressed solely through implementation of the pollution reduction measures identified in Chapter 2. All development and redevelopment projects must comply with City source control guidance. Source control requirements are in addition to the applicable destination/disposal, pollution reduction, and flow control requirements identified in this chapter.

Source controls apply to all projects with the defined uses or characteristics listed in City source control guidance including: new development, redevelopment, tenant improvements or those existing sites proposing new off-site discharges. With tenant improvements, only those areas of a structure or activity area that are being disturbed under the permit are required to make the structural changes identified in this chapter. With new off-site discharges only those proposed areas draining off-site will be subject to these regulations.

Potential high risk areas that will require special considerations by the City are:

- ***Covered Fueling Areas*** where there is no drainage system. All fueling areas should have a collection system that directs flow from the surface to a sanitary sewer. These flows will need to meet any conditions of the City's Pretreatment Program.

Parking garage stormwater runoff treatment requirements are dependent on the source floor. Runoff from the top floor must be captured, treated, and discharged as directed

by Chapter 2 of this manual whereas runoff from other floors may be conveyed to the sanitary sewer.

No exceptions to meeting the stormwater management obligations are allowed. The developer shall either construct stormwater management facilities or pay the City to build off-site facilities. Except as listed above, on-site stormwater management shall be achieved to the maximum extent practicable, as approved by the City Engineer, in all cases before any off-site facilities or fees will be allowed.

In reviewing the applicant's plan submittal, the City will use the following criterion to determine if a special circumstance claim is allowed:

- Has the applicant made maximum use of on-site facilities identified in Chapter 2.0 for pollution reduction and/or flow control?

Applicants who are citing special circumstances are encouraged to obtain early assistance from City Engineering.

Form SC	Special Circumstances

See Section 1.10 for requirements pertaining to Special Circumstances.

Part I: Identification of Special Circumstance(s)

Check all special circumstance(s) that apply:

☐ The site contains sensitive ecological or cultural features, or natural features that provide significant water quality or environmental benefits that should not be disturbed. There is no opportunity to avoid impact from facilities.

☐ On-site management would significantly increase the risk of landslides and slope instability.

☐ The project is declared emergency work, where there is a hazard posing imminent danger to life or property.

☐ Structural, natural, or other physical limitations at the site constrain the function, placement, or necessary maintenance of on-site pollution reduction or flow control measures.

☐ The City Engineer has determined that the use of an off-site regional facility is a better approach to achieve pollution reduction and flow control benefits.

☐ The project is a "linear" facility (e.g., sidewalk, bike lane) in an existing public right-of-way, and site conditions make it impractical to construct an on-site facility, as determined by the City Engineer.

☐ High risk areas as described in Sections 1.9 and 1.10 of the Stormwater Management Manual. This is to include any surface areas where drainage is being directed to a sanitary sewer and requiring pre-treatment.

Form SC **(Continued)**	**Special Circumstances**

Part II: Effects on Construction of On-site Stormwater Management

Describe the limiting effect(s) of the special circumstance(s) on the construction of on-site stormwater management facilities (pollution reduction, flow control, and destination):

Part III: Stormwater Management Percentages Achieved On and Off-Site

Indicate the portion of the site to be managed for pollution reduction:

On-site:	**Off-site:**

Indicate the portion of the site to be managed for flow control:

On-site:	**Off-site:**

Part IV: Proposed On and Off-site Stormwater Management Method(s)

Also describe the on and off-site stormwater management methods to be used for pollution reduction and flow control. State "off-site management fee" if applicable.

Chapter 2.0
STORMWATER MANAGEMENT FACILITY DESIGN

Summary of Chapter 2.0

This chapter provides procedures for selecting and designing facilities that provide stormwater pollution reduction, flow control, and/or disposal benefits. It includes:

To Use This Chapter:

1) Use **Chapter 1.0** to determine the pollution reduction and flow control requirements for the project.
2) Select stormwater management facilities from **Section 2.9: Facility Design Criteria** to meet pollution reduction and flow control requirements for the project.
3) Size facilities using the **simplified approach**, **presumptive approach**, or **performance approach** presented in this chapter. For simplified approach facilities, use **Form SIM** for sizing. For presumptive and performance approach facilities, use specific sizing criteria presented with each facility type and hydrologic analysis methods listed in **Section 2.3**. Integrate the facilities into the project's overall site plan.
4) Prepare drawings and specifications for each stormwater management facility in accordance with the design criteria in **Section 2.9: Facility Design Criteria**.
5) Consult **Chapter 3.0** for the operations and maintenance requirements for each stormwater management facility.

2.1 INTRODUCTION & APPLICABILITY

Facilities presented in this chapter receive credit for pollution reduction, flow control, disposal, or in some cases a combination of the three. Three methodologies are included in this chapter for the sizing and design of stormwater management facilities: the simplified, presumptive, and performance approach. Each design approach has limitations on applicability. See **Exhibit 2-1** for a list of the facility types and their applicable design methodologies.

Exhibit 2-1: Stormwater Management Facility Design Methodology Table

Stormwater Management Facility Type	Pollution Reduction	Flow Control
Pervious pavement*	Simplified	Simplified
Tree credit*	Simplified	Simplified
Infiltration planter*	Simplified[1]	Simplified
Flow-through planter	Simplified[1]	Simplified
Vegetated swale*	Simplified[1]	Simplified
Grassy swale* < 15,000 sq-ft impervious area	Simplified[1]	Simplified
Grassy swale* > 15,000 sq-ft impervious area	Presumptive	NA
Street swales*	Simplified[1]	Simplified
Vegetated filter*	Simplified[1]	Simplified
Vegetated infil. Basin*	Simplified[1]	Simplified
Wet pond*	Presumptive	NA
Extended wet det. pond	Presumptive	Presumptive
Dry detention pond	Presumptive[3]	Presumptive
Constructed treatment wetland*	Presumptive	Presumptive
Manufactured treatment technology	Presumptive[4]	NA
Structural det. facility	NA	Presumptive
Spill control manhole	Presumptive[2]	NA
Rainwater harvesting	Performance	Performance

* = Treatment technique incorporates infiltration

Exhibit 2-1 Notes:

[1] The performance approach may be used to downsize these simplified approach facilities.

[2] Spill control manholes receive credit for oil removal only; additional pollution reduction facilities will be required to meet basic TSS removal requirements.

[3] Vegetated or grassy swales must be integrated into the bottom of dry detention ponds to receive pollution reduction credit.

[4] Manufactured treatment technologies must be pre-approved by the City Engineer to receive presumptive approach credit for pollution reduction.

2.2 DESIGN METHODOLOGIES

2.2.1 Simplified Approach

The simplified approach is a relatively easy process for selecting and designing pollution reduction and flow control facilities, intended to save the project developer and the City time and expense. Combination facilities can be more practical to build than separate pollution reduction and flow control facilities. Facilities sized using the simplified approach retain stormwater near the ground surface, which provides a number of benefits, including pollution reduction, groundwater recharge and protection, peak flow reduction, and volume reduction. Rather than detaining stormwater and releasing it off-site at increased post-developed volumes, these facilities help infiltrate or retain water on-site. In areas with surface drainageways and streams, on-site retention lessens the "flashy" high- and low-flow impacts created by development in watershed basins. Stream erosion and temperature impacts are also decreased. Overall, these facilities help mimic the natural hydrologic cycle by slowing and infiltrating stormwater.

Simplified Approach Sizing

Facilities designed in accordance with the simplified approach are presumed to comply with the City's pollution reduction and flow control requirements (see **Chapter 1.0**). The facilities must also include an overflow to an acceptable disposal point for large storm events

A technical process was used to determine facility designs and sizes that would be effective on development sites. The process included a review of technical literature, review of monitoring data, calculations, and theoretical analysis. Sizing factors for the simplified approaches (shown on **Form SIM** below) were developed as a simple and quick tool to use for site planning and to accelerate permit review and approval. Generalized assumptions were used that may result in conservative sizing for some development sites. Manual users have the option to use the sizing factors as given on Form SIM, or follow the performance approach and submit an alternative facility size, along with supporting engineering calculations for the City Engineer to review and consider. The performance approach may be used to downsize facilities in circumstances when flow control is not required.

Appendix C: *Simplified Approach Sizing Calculations* provides information about how facility sizing factors were developed, and guidance on how the same methodology can be used to develop alternative facility sizes. An approved hydrologic analysis method (**Section 2.3**), such as a Santa Barbara Urban Hydrograph (SBUH) based approach must be used to generate flow rates and volumes for design analysis. When facilities are

downsized to meet pollution reduction requirements only, flows above the pollution reduction design flow must be routed around the facility with an approved diversion structure (**Section 2.5**) unless approved otherwise by the City Engineer.

The first facility types on Form SIM (tree credits) and pervious pavements are impervious area reduction or mitigation techniques, and should be used first during the site planning and design stage to reduce the overall square-footage of impervious area that requires stormwater management. These facilities intercept rainfall, and are not generally designed to receive stormwater runoff. The second group of facilities listed on Form SIM (infiltration and flow-through planter boxes, vegetated and grassy swales, vegetated filter strips and infiltration basins, and sand filters) are designed to receive stormwater runoff from impervious surfaces.

Simplified Approach Submittal Requirements

Applicants using the simplified approach shall submit **Form SIM** as part of their permit application, along with construction drawings and details. **Page 2 of Form SIM** can be used to claim stormwater management credit for planting new trees and retaining existing tree canopy on-site. A copy of the operations and maintenance plan (see **Chapter 3.0**) shall also be included. In addition, a geotechnical report may be required by the City Engineer to evaluate the suitability of the proposed facility location.

City of Grants Pass Form SIM: Simplified Approach for Stormwater Management

The city has produced this form to assist with a quick and simple approach to manage stormwater on-site.
Facilities sized with this form are presumed to comply with pollution reduction and flow control requirements.

INSTRUCTIONS	SITE INFORMATION	
1. Enter square footage of new or redeveloped impervious site area.	(1) Impervious Area	sf
2. Select impervious area reduction techniques from rows "a" and "b" to reduce the site's resulting stormwater management requirement. Tree credit can be calculated using the tree credit worksheet page 2.	(2) Credits	sf
3. Subtract (2) from (1) to calculate required mitigation area: (3) = (2) - (1)	(3) Required Mitigation Area	sf
4. Select desired stormwater management facilities from rows "c" - "h". In Column 1 enter the square footage of impervious area that will flow into each facility type.		
5. Multiply each impervious area from Column 1 by the corresponding sizing factor in Column 2, and enter the result in Column 3. This is the facility surface area needed to manage runoff from the impervious area.		
6. Total Column 1 (Rows "c" - "h") and enter the resulting "Impervious Area Managed" on line (6).	(6) Total Impervious Area Managed	sf
7. Subtract (6) from (3) and enter the result on line (7). When this number reaches 0, stormwater pollution reduction and flow control requirements have been met. Submit this form with the application for permit. (7) = (6) - (3)	(7) Remaining Area	sf
8. If line (7) is greater than 0 square feet, add square footage or facilities to Column 1 and recalculate, or use additional facilities from Chapter 2.0 of the Stormwater Management Manual to manage stormwater from these remaining impervious surfaces.		

	Column 1	Column 2	Column 3
Impervious Area Reduction Technique	**Impervious Area Managed = Facility Surface Area**		
a. Tree Credit (see page 2)	sf		*sf = square feet*
b. Pervious Pavement	sf		

Stormwater Management Facility*	**Impervious Area Managed**		**Sizing Factor**		**Facility Surface Area**	**Unit**
c. Infiltration Planter	_____	sf	x 0.07	=	_____	sf
d. Flow-Through Planter	_____	sf	x 0.07	=	_____	sf
e. Vegetated Swale	_____	sf	x 0.11	=	_____	sf
f. Grassy Swale	_____	sf	x 0.14	=	_____	sf
g. Vegetated Filter Strip	_____	sf	x 0.24	=	_____	sf
h. Vegetated Infil. Basin	_____	sf	x 0.11	=	_____	sf
i. Total Impervious Area Managed (Sum of Column 1, Rows "c" - "h")	_____	sf				

Form SIM (Page 2): Tree Credit Worksheet

See **Tree Credits** in Section 2.9 for more information regarding the use of trees to meet stormwater management requirements.

New Evergreen Trees

To receive stormwater management credit, new evergreen trees must be planted within 25 feet of ground-level impervious surfaces. New trees cannot be credited against rooftop surfaces. Minimum tree height (at the time of planting) to receive credit is 6 feet.

Enter number of new evergreen trees that meet qualification requirements in Box A ____ **Box A**

Multiply Box A by 200 and enter result in Box B ____ **Box B**

New Deciduous Trees

To receive stormwater management credit, new deciduous trees must be planted within 25 feet of ground-level impervious surfaces. New trees cannot be credited against rooftop surfaces. Minimum tree caliper (at the time of planting) to receive credit is 2 inches.

Enter number of new deciduous trees that meet qualification requirements in Box C ____ **Box C**

Multiply Box C by 100 and enter result in Box D ____ **Box D**

Existing Tree Canopy

To receive stormwater management credit, existing tree canopy must be preserved during and after construction. Existing tree canopy must be within 25 feet of ground-level impervious surfaces. Existing trees cannot be credited against rooftop surfaces. Minimum tree caliper to receive credit is 4 inches. No credit will be given to existing tree canopy located within environmental zones. Tree canopy is measured around the tree's drip line.

Enter square-footage of existing tree canopy that meets qualification requirements in Box E ____ **Box E**

Multiply Box E by 0.5 and enter the result in Box F ____ **Box F**

Total Tree Credit

Add boxes B, D, and F and enter the result in Box G ____ **Box G**

For sites with less than 3,500 square-feet of new or redeveloped impervious area:
The amount in Box G is to be entered as "Tree Credit" on Form SIM. ** Stop Here **

For sites with more than 3,500 square-feet of new or redeveloped impervious area:
Multiply Box 1 of Form SIM by 0.1 and enter the result in Box H ____ **Box H**

Enter the lesser of Box G and H in Box I. ____ **Box I**
This is the amount to be entered as "Tree Credit" on Form SIM. **Stop Here**

2.2.2 Presumptive Approach

Facilities that utilize this design approach are classified as "presumptive," *presumed* to be in compliance with the City's pollution reduction, flow control, and/or disposal requirements if the presented sizing and design requirements are followed.

There are a few key differences between the presumptive and simplified approach sizing methodologies. Stormwater management goals that require the presumptive approach to be used for a particular facility type do not lend themselves well to simplified sizing. More detailed hydrologic calculations must be performed to adequately design the facility to achieve the desired goal. Another difference is that the presumptive approach presents sizing methodologies that meet the requirements of one particular goal (pollution reduction, flow control, or disposal), rather than multiple goals. See **Exhibit 2-1** earlier in this chapter for the table that specifies the design approaches that are applicable to each management goal, for each facility type.

Presumptive Approach Submittal Requirements

In addition to detailed construction drawings and specifications shown on permit drawings, all applicants using the presumptive approach for stormwater management are required to submit a detailed stormwater report. This report shall include a general description of the stormwater facility and how it is intended to function. It shall include detailed hydraulic calculations, as summarized in **Exhibit 2-2** on the following page. A copy of the operations and maintenance plan (see **Chapter 3.0**) shall also be provided. In addition, a geotechnical report may be required by the City Engineer to evaluate the suitability of the proposed facility location.

Exhibit 2-2:
Checklist of Calculations to be Included in Stormwater Report

Stormwater Facility Type
A= Grassy Swale
B= Wet Pond
C= Extended Wet Detention Pond
D= Dry Detention Pond
E= Constructed Treatment Wetland
F= Detention Tank, Vault, or Pipe
G= Manufactured Treatment Technology or Spill Control Manhole

Parameter or Calculated Value to be Included in the Stormwater Report	A	B	C	D	E	F	G
Site Variables:							
Site soil type (A, B, C, or D)	x	x	x	x	x	x	x
Contributing area (acres)	x	x	x	x	x	x	x
Pre-developed curve number (CN)			x	x	x	x	
Pre-developed time of concentration T of C (minutes)			x	x	x	x	
Post-developed curve number (CN)	x	x	x	x	x	x	x
Post-developed time of concentration T of C (minutes)	x	x	x	x	x	x	x
Distance from ground surface to max. height of seasonal groundwater (feet)	x	x	x	x	x	x	x
Hydrographs:							
Pre-developed hydrographs for the 2, 5, 10, 25, and 100-year storms, including peak rates and total volumes			x	x	x	x	
Post-developed hydrographs for the 2, 5, 10, 25, and 100-year storms, including peak rates and total volumes (only if routed through the facility)			x	x	x	x	
Post-developed hydrographs for the 2, 5, 10, 25, and 100-year storms after being routed through the facility, including peak rates and total volumes			x	x	x	x	
Facility Geometry:							
Table showing area and volume of the facility every 6" in elevation		x	x	x	x	x	
Side slopes (h: v or %)	x	x	x	x	x		
Longitudinal slope (h: v or %)	x				x		
Bottom width and length (feet)	x	x	x	x	x		
Overall width and length (feet)	x	x	x	x	x		
Hydraulic Controls:							
Orifice or weir descriptions, sizes, and elevations, including by-pass facilities			x	x	x	x	
Elevation, size, and type of overflow spillway or pipe	x	x	x	x	x	x	x
Calculated Values:							
Pollution reduction flow rate	x						x
Pollution reduction permanent pool volume and elevation		x	x		x		
Forebay volume and elevation		x	x	x	x		
Hydraulic residence time for the pollution control storm	x				x		
Storm routing data showing the peak water surface elevation in the facility for the 2, 5, 10, 25, and 100-year storms (only if routed through the facility)	x	x					x
Detailed storm routing data for the 2, 5, 10, 25, and 100-year storms, showing inflow rate, outflow rate, and water surface elevation in the facility every 10 minutes throughout the storm.			x	x	x	x	

SURFACE INFILTRATION DESIGN APPROACH FOR DISPOSAL

Where soil conditions allow for percolation near the ground surface, surface infiltration facilities can be used to dispose of stormwater from large storm events. The infiltration of stormwater near the ground surface helps increase the separation to groundwater, providing a greater filtration layer and decreasing the risk of groundwater contamination. It also serves to mimic the predevelopment hydrologic cycle, decreasing downstream impacts by recharging groundwater and increasing evapotranspiration.

Examples of surface infiltration facilities that can be designed under this approach include vegetated, grassy, and street swales, infiltration planters, and vegetated infiltration basins. While the design procedure in this section accounts for complete on-site infiltration of the stormwater from new impervious surface area, facilities sized per the simplified approach must include an overflow to an acceptable disposal point.

Surface Infiltration Design Approach to Meet Disposal Standards

1) Determine the preliminary facility size by calculating the runoff volume generated by the 10-year storm (4.2 inches of rainfall over 24 hours, NRCS Type 1A rainfall distribution). The SBUH method can be used to determine this volume, or the volume can be approximated by the following formula:

   Runoff Volume (cubic feet) = 0.35 feet * Impervious Area (square-feet)

   The facility will need to be capable of containing this volume of runoff through a combination of above ground storage and below ground storage within voids in a subsurface rock trench.

2) Surface infiltration facilities require infiltration tests during the design phase of the project. For public facilities, double-ring infiltrometer tests shall be conducted, in accordance with ASTM D3385-94, with City Engineering review and approval. For private facilities, the falling head infiltration test procedure specified in **Section 2.4.2** shall be used. The minimum acceptable infiltration rate for surface infiltration facilities to meet disposal standards is 2 inches per hour. A clogging factor of 4 is then applied to the resulting infiltration rate to be used in the design of the facility.

3) The design infiltration rate (measured infiltration rate divided by 4) is then used to check the facility drawdown time. When full, the facility drawdown time shall not exceed 30 hours.

4) The wet seasonal high water table must be determined, and a minimum 4-foot clearance to bottom of facility must be maintained.

5) The 100-year storm inundation area shall be determined and must show that structures will not be flooded and that property damage and safety risks will be avoided.

6) Minimum setbacks from surface infiltration facilities to structures are shown in **Exhibit 2-4**.

7) All areas to be used as surface infiltration facilities shall be back-filled with a suitable sandy loam planting and filtration medium. Minimum depth shall correspond to each facility type's specification. The borrow source of this medium, which may be the same or a different location from the facility area itself, must be tested as follows:

   If the borrow area is virgin, undisturbed soil, one test is required per 200 square-feet of borrow area. The test consists of "grab" samples at 1-foot depth intervals to the bottom of the borrow area. All samples at the testing location are then mixed, and the resulting sample is laboratory tested to meet the following criteria:

   USDA minimum textural analysis requirements: A textural analysis is required from the site-stockpiled topsoil. If topsoil is imported, a textural analysis shall be performed for each location where the topsoil was excavated.

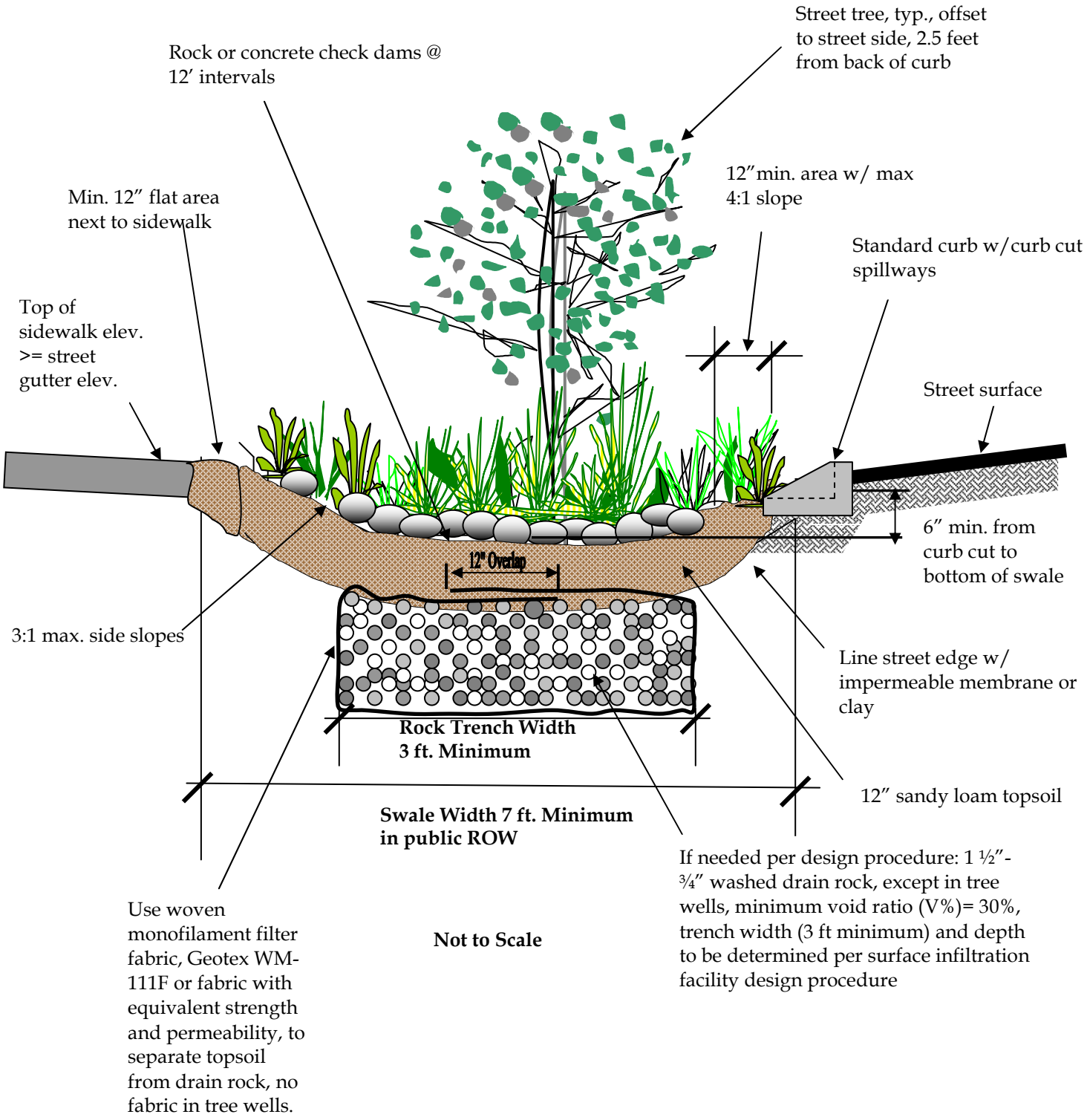
   Requirements:
   Sand 35 – 60%
   Silt 30 – 55% (Loam)
   Clay 10 – 25%

   The soil shall be a uniform mix, free of stones, stumps, roots, or other similar objects larger than two inches.

8) Surface infiltration facility areas shall be clearly marked before site work begins to avoid soil disturbance during construction. No vehicular construction traffic, except that specifically used to construct the facility, shall be allowed within 10 feet of surface infiltration facility areas.

9) For surface infiltration facilities, post-construction field infiltration testing will be required. Methods consistent with those used during design of the facilities shall be used. The resulting infiltration rate must show that the facility drawdown time will not exceed 30 hours.

Exhibit 2-3: Example Cross-Section of Vegetated Street Swale



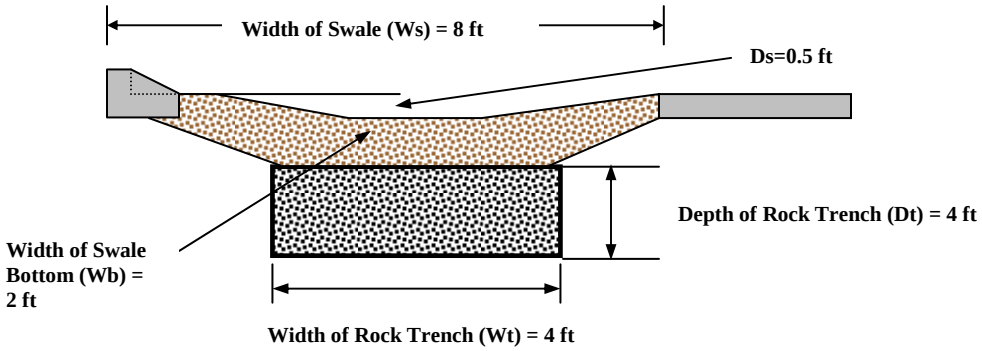
SURFACE INFILTRATION FACILITY SIZING EXAMPLE

Facility Type: Vegetated Street Swale

Objective: Find swale dimensions needed to meet stormwater disposal standards.

Givens: Design Storm (P) = 10 year, 24 hour storm = 4.2 total inches = **0.35 feet**
Maximum Drawdown Time (Td) = **30 hours**
Infiltration Rate Safety Factor = **4**

Site Characteristics:
Impervious Area (Ai) = 200′ x 28′ = **5,600 square feet**
Measured Infiltration Rate (Im), using Double-Ring Infiltrometer Test = 12″/hr = **1′/hr**
Swale width (Ws) = **8 feet**
Swale bottom width (Wb) = **2 feet**
Swale depth (Ds) = **0.5 feet**
Rock trench width (Wt) = **4 feet**
Rock trench depth (Dt) = **4 feet**
Void Ratio of Rock Trench (VR) dimensionless = **0.30**



Calculations:
Runoff Volume (Vr) cubic feet = P * Ai = 0.35 * 5,600 = **1,568 cubic feet**
Design Infiltration Rate (Id) feet per hour = Im / 4 = 1 ft/hr / 4 = **0.25 ft/hr**
Swale Storage Volume (Vs) = L * [(0.5 * Ds * (Ws + Wb)) + (VR * Wt * Dt)]

Check #1: Runoff Volume (Vr) must be less than or equal to Swale Storage Volume (Vs)

$$Vr <= Vs$$

$$(0.35 * Ai) <= L * [(0.5 * Ds * (Ws + Wb)) + (VR * Wt * Dt)]$$

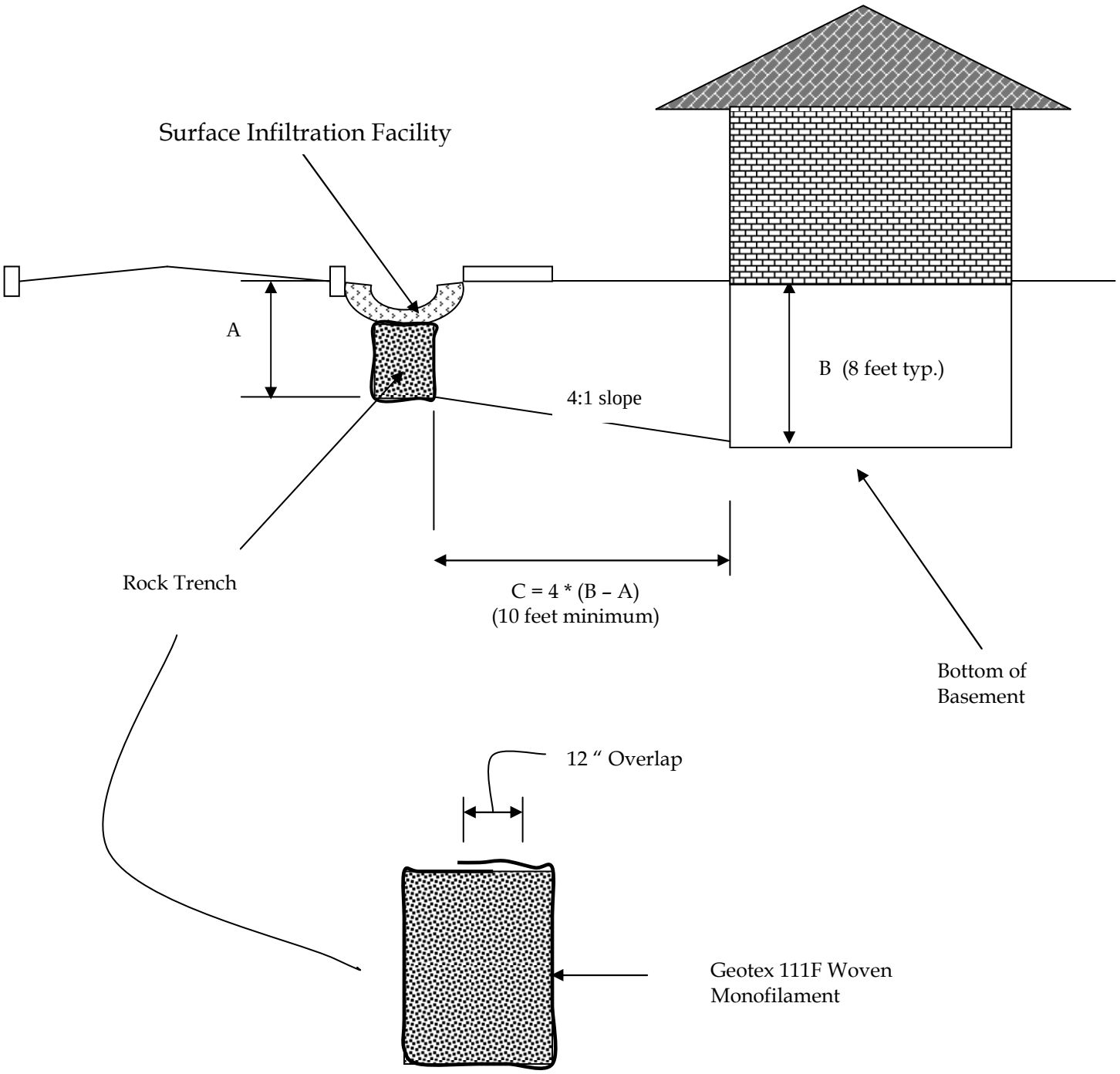
To find L: L = (0.35 * Ai) / [(0.5 * Ds * (Ws + Wb)) + (VR * Wt * Dt)]
L = (0.35 * 5,600) / [(0.5 * 0.5 * (8 + 2)) + (0.30 * 4 * 4)] = 268.5 feet

Check #2: Swale drawdown time must not exceed maximum allowable (Td) = 30 hours

$$(0.35 * Ai) / (Id * Wt * L) <= 30 \text{ hours}$$

(0.35 * 5,600) / (0.25 * 4 * 215) = 7.3 hours < 30 hours, therefore OK

Exhibit 2-4: Surface Infiltration Facility Setback Detail



2.2.3 Performance Approach

The list of accepted stormwater management facilities is continually changing as new products are developed and more is learned about the performance of facilities already in use. Design professionals may propose facilities other than those included in this manual by using the performance approach. Design professionals may also use the performance approach to show that a facility is capable of reducing a TMDL pollutant of concern (See **Exhibit 1-2**).

The performance approach requires detailed engineering design and calculations, as well as documented evidence of the proposed design's performance. The City will accept the proposed design for meeting pollution reduction requirements if the design professional demonstrates that it:

- Will perform at the required efficiency: 70 percent total suspended solids (TSS) removal from 1/3 of the 2 year storm (See **Section 1.5**), and is capable of reducing the TMDL pollutant of concern (if applicable).

- Can be efficiently maintained to perform at the required level, and for public facilities, will not require more costly maintenance than facilities designed using the simplified or presumptive approach.

Performance Approach Submittal Requirements

In addition to detailed construction drawings and details to be shown on permit drawings, all applicants using the performance approach for stormwater management are required to submit a detailed stormwater report. This report shall include a description of the stormwater facility, how it is intended to function, and documented evidence of the proposed design's performance. It shall include detailed hydraulic calculations as summarized in **Exhibit 2-2** and must demonstrate the performance criteria listed above. A copy of the operations and maintenance plan (see **Chapter 3.0**) shall also be included. In addition, a geotechnical report may be required by the City Engineer to evaluate the suitability of the proposed facility location.

2.3 HYDROLOGIC ANALYSIS REQUIREMENTS

With the exception of pollution reduction and flow control facilities designed using the simplified approach, stormwater management facilities must be designed using hydrologic analysis methods described below. If one of the hydrologic analysis methods discussed below is not used, the City Engineer must pre-approve the alternative method before the plans and calculations are submitted. Regardless of how the hydrologic calculations are performed, all hydrologic submittals shall include data necessary to facilitate the City Engineers review. This data is summarized in **Exhibit 2-2**.

2.3.1 Pollution Reduction

Flow Rate-Based Facilities: With the exception of facilities sized using the simplified approach, the City will use the SBUH or Rational Method (if approved by City Engineer) with rainfall intensities presented in **Section 1.5.2** to verify flow rates used to size rate-based pollution reduction facilities. Intensities have been calculated to treat 1/3 of the 2 year 24 hour storm.

Flow Volume-Based Facilities: Volume-based pollution reduction facilities included in this manual (wet ponds and extended wet detention ponds) are required to use the pre-determined volume of 0.93 inches over 24 hours with a Vb/Vr (volume of basin/ volume of runoff) ratio of 2 to be in presumptive compliance.

Combination Rate/Volume-Based Facilities: With the exception of facilities sized using the simplified approach, the City will use a software program (several are available for free via the Internet, one example is HydroCAD, http://www.hydrocad.net) utilizing the Santa Barbara Urban Hydrograph (SBUH) method to verify the sizing of flow rate-based pollution reduction facilities that also rely on a storage volume component. An example of this includes the downsizing of simplified approach facilities (such as vegetated swales and infiltration basins) to achieve pollution reduction only. When using SBUH, a 0.93 inch, 24-hour storm with NRCS type 1A rainfall distribution shall be used.

2.3.2 Flow Control

With the exception of facilities sized using the simplified approach, the City will use a software program based on the Santa Barbara Urban Hydrograph (SBUH) to check design calculations for flow control facilities.

2.3.4 Conveyance

Please reference the City of Grants Pass's Engineering Standards for acceptable hydrologic analysis methods for stormwater conveyance. The Rational Method will be used to verify design calculations for pipe or surface conveyance facility sizing. If the drainage system being analyzed is over 100-acres the applicant should discuss hydrologic modeling with the City engineer prior to conducting the analysis.

2.3.5 Hydrologic Analysis Method Resources

The **Santa Barbara Urban Hydrograph (SBUH) Method** (**See Appendix C**) may be applied to small, medium, and large projects. It is a recommended method for completing the analysis necessary for designing flow control facilities when not using the simplified approach.

2.4 INFILTRATION TESTING

To size stormwater management facilities, it is often necessary to know the infiltration rate of the soil at the actual facility location. The following general criteria apply to all proposed infiltration facilities:

1) For all surface infiltration facilities being designed to meet disposal standards, a minimum infiltration rate of 2 inches per hour is required. Site-specific facility design may require a much higher infiltration rate.
2) Testing can be classified into three categories, (1) initial feasibility testing, (2) design testing, and (3) post-construction testing. (see **Exhibit 2-5**)
3) Testing shall be conducted or observed by a qualified professional. This professional shall either be a registered professional engineer in the State of Oregon, or a soils scientist or geologist licensed in the State of Oregon.
4) All field-testing must be done in the proposed area of the facility.
5) Testing data shall be documented, including a description of the infiltration testing method.

Applicant is responsible for all testing and inspection costs.

2.4.1 Initial Feasibility Testing

Initial feasibility testing is conducted to determine whether full-scale testing is necessary, and is meant to screen unsuitable sites and reduce testing costs. It involves either one field test per facility (regardless of type or size) or previous testing data, such as the following:

- Pre-approval from the City Engineer
- Septic percolation testing on-site, within 200 feet of the proposed facility location and on the same contour
- Previous written geotechnical reporting on the site location as prepared by a qualified geotechnical expert
- NRCS Josephine County Soil Mapping showing unfeasible conditions such as a hydrologic group "D" soil in a low-lying area

If the results of initial feasibility testing as determined by a qualified professional show that an infiltration rate of greater than 2 inches per hour is probable, then the design and post-construction testing shall be in accordance with **Exhibit 2-5**. The City Engineer may waive design-testing requirements if it is determined that adequate testing data exist. In the case of infiltration testing, an encased soil boring may be substituted for a test pit, if desired.

If a surface Infiltration Facility is being proposed, one double-ring infiltrometer test (for public facilities) or one falling head test (for private facilities) per 200 square feet of facility area will be required.

2.4.2 Design Testing

Where required, the following **test pit** procedure shall be followed:

1) Excavate a test pit or dig a standard soil boring to a minimum depth of 4 feet below the proposed facility bottom elevation. Also conduct Standard Penetration Testing (SPT) every 2 feet to a depth of 4 feet below the facility bottom.
2) Determine depth to highest seasonal groundwater table (if within 4 feet of proposed bottom) upon initial digging or drilling.
3) Determine USDA or Unified Soil Classification System textures at the proposed bottom and 4 feet below the bottom of the facility.
4) Determine depth to bedrock (if within 4 feet of proposed bottom).
5) The soil description should include all soil horizons.
6) The location of the test pit or boring shall correspond to the facility location; test pit/soil boring stakes are to be left in the field for inspection purposes and shall be clearly labeled as such.

Where required, the following **falling head infiltration test** procedure shall be followed:

1) Install casing (solid 5-inch diameter, 36-inch length) to 24 inches below proposed facility bottom (see **Exhibit 2-6**).
2) Remove any smeared soiled surfaces and provide a natural soil interface into which water may percolate. Remove all loose material from the casing. Upon the tester's discretion, a 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scouring and sediment. Fill casing with clean water and allow to pre soak for 24 hours, or until the water has completely infiltrated.
3) Refill casing and monitor water level (measured drop from the top of the casing) for 1 hour. Repeat this procedure (filling the casing each time) three additional times, for a total of four observations. Upon the tester's discretion, the final field rate may either be the average of the four observations or the value of the last observation. The final rate shall be reported in inches per hour.
4) Testing may be done through a boring or open excavation.
5) The location of the test shall correspond to the facility location.
6) Upon completion of the testing, the casings shall be immediately pulled, and the test pit shall be back-filled.

Where required, the **double-ring infiltrometer test** procedure must follow ASTM D3385-94, standard test method for infiltration rate of soils in field using double-ring infiltrometer.

2.4.3 Post-Construction Testing

See surface infiltration facility design section for post-construction infiltration testing requirements. The City Engineer may require post-construction testing.

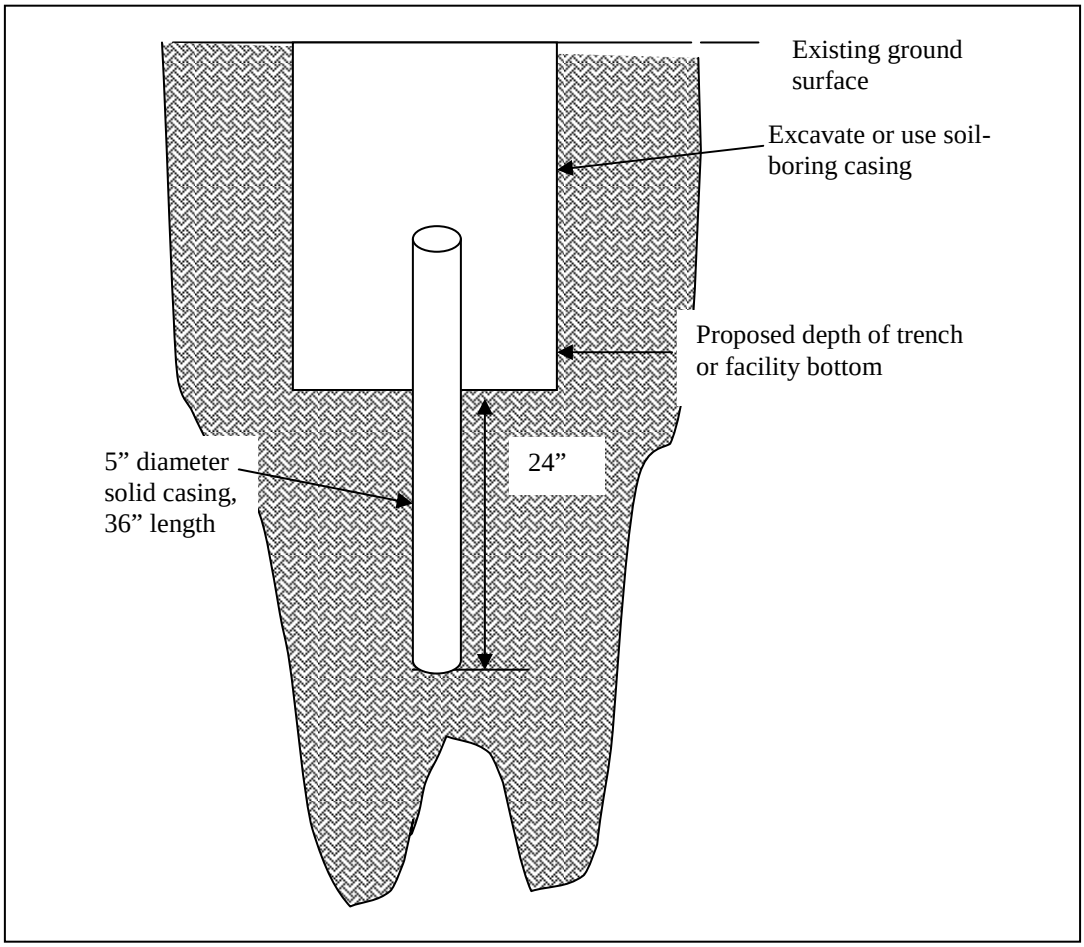
Exhibit 2-5: Infiltration Testing Summary Table

Type of Facility	Initial Feasibility Testing (Section 2.4.1)	Design Testing (Section 2.4.2)	Post-Construction Testing (Section 2.4.3)
Private Soakage Trench	Required	One test pit and one falling head test per soakage trench, unless waived by City	Not applicable.
Surface Infiltration Facility	Required	One double-ring infiltrometer test (for public facilities) or one falling head test (for private facilities) per 200 square-feet of facility area	May be required by City. (see **surface infiltration facility** design section for procedure)

2.4.4 Laboratory Testing

Grain-size sieve analysis and hydrometer tests where appropriate may be used to determine USDA soils classification and textural analysis. Visual field inspection by a qualified professional may also be used, provided that it is documented. The use of laboratory testing to establish infiltration rates is prohibited.

Exhibit 2-6: Falling Head Test Requirements



2.5 CONTROL STRUCTURES FOR DETENTION SYSTEMS

This section presents the methods and equations for the design of flow restricting control structures, for use with extended wet detention ponds, dry detention ponds, and structural detention facilities. It includes details and equations for the design of orifices, and equations for rectangular sharp crested weirs and v-notch weirs.

Weir and orifice structures must be enclosed in a catch basin, manhole, or vault, and must be accessible for maintenance.

2.5.1 Design Requirements

The following criteria apply to control structure design.

- The control structure shall be designed to pass the 100-year storm event as overflow without causing flooding of the contributing drainage area.

Orifices

- Orifices may be constructed on a "tee" riser section (see **Exhibit 2-7**) or on a baffle (see **Exhibit 2-8**).

- The minimum allowable diameter for an orifice used to control flows in a public facility is 2 inches. Private facilities may utilize a 1-inch diameter orifice if additional clogging prevention measures are implemented. The orifice diameter shall always be greater than the thickness of the orifice plate.

- Multiple orifices may be necessary to meet the 2- through 25-year design storm performance requirements for a detention system. However, extremely low flow rates may result in the need for small orifices (< 1-inch for private facilities, < 2-inch for public) that are prone to clogging. In these cases, retention facilities that do not rely on orifice structures shall be used to the maximum extent practicable to meet flow control requirements (see **Section 1.6.2**). Large projects may also result in high flow rates that necessitate excessively large orifice sizes that are impractical to construct. In such cases, several orifices may be located at the same elevation to reduce the size of each individual orifice.

Orifice Sizing Equation:

$$Q = C A \sqrt{2gh}$$

where:

Q = Orifice discharge rate, cfs
C = Coefficient of discharge, feet (suggested value = 0.60 for plate orifices)
A = Area of orifice, square feet
h = hydraulic head, feet
g = 32.2 ft/sec^2

The diameter of plate orifices is typically calculated from the given flow. The orifice equation is often useful when expressed as an equivalent orifice diameter in inches.

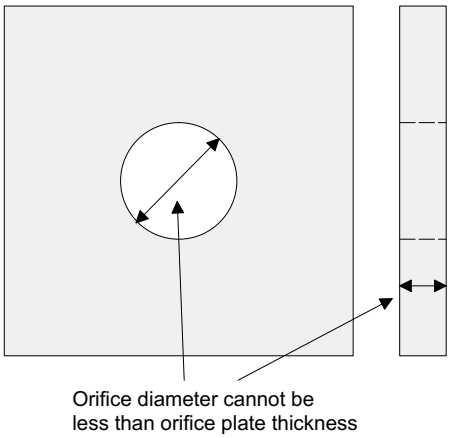
$$d = \sqrt{\frac{36.88\,Q}{\sqrt{h}}}$$

where:

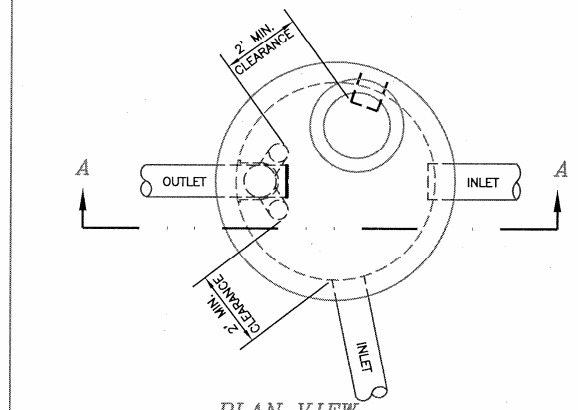
Q = flow, cfs
d = orifice diameter, inches
h = hydraulic head, feet

- Orifices shall be protected within a manhole structure, or by a minimum 18-inch-thick layer of 1½" to 3" evenly graded, washed rock. Orifice holes shall be externally protected by stainless steel or galvanized wire screen (hardware cloth) with a mesh of 3/4" or less. Chicken wire shall not be used for this application.

- Orifice diameter shall be greater than or equal to the thickness of the orifice plate (see diagram).



- If less than 3 inches in diameter, the orifice shall not be made of concrete. A thin material (e.g., stainless steel, HDPE or PVC) shall be used to make the orifice plate; the plate shall be attached to the concrete or structure.



PLAN VIEW

NOTES:

1. EXCEPT AS SHOWN OR NOTED, UNITS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE REQUIREMENTS FOR LARGER PRE CAST CONCRETE MANHOLE, PER C.O.P. STANDARD PLAN 4–08–1.

2. FOR DETAILS SHOWING GRADE RING, STEPS, MANHOLES, AND TOP SLABS, SEE C.O.P. STANDARD PLAN 4–08–1.

3. PIPE SUPPORTS SHALL ANCHORED AT 3' MAX. SPACING BY 3/8 DIA. STAINLESS STEEL EXPANSION BOLTS EMBEDDED 2" IN WALL.

4. THE RESTRICTOR/SEPARATOR SHALL BE FABRICATED FROM SOLID WALL HDPE PIPE, OR APPROVED EQUAL.

5. OUTLET SHALL BE CONNECTED TO RESTRICTOR PIPE WITH A FLEXIBLE COUPLING.

6. THE VERTICAL RISER STEM OF THE RESTRICTOR/ SEPARATOR SHALL BE THE SAME DIAMETER AS THE HORIZONTAL OUTLET PIPE. WITH A 10" MINIMUM DIAMETER.

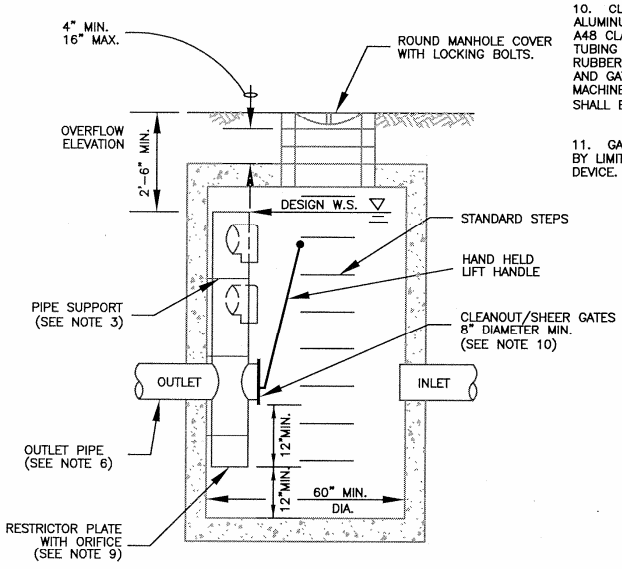
7. FRAME AND STEPS ARE TO BE OFFSET SO THAT:
   A. CLEAN OUT GATE IS VISIBLE FROM TOP
   B. CLIMB–DOWN SPACE IS CLEAR OF RISER AND GATE.
   C. FRAME IS CLEAR OF CURB (IF ANY EXISTS).

8. MULTI–ORIFICE ELBOWS MAY BE LOCATED AS SHOWN OR ALL ON ONE SIDE OF RISER TO ASSURE LADDER CLEARANCE. SIZE OF ELBOWS AND PLACEMENT TO BE CLEARLY LABELED ON THESE PLANS.

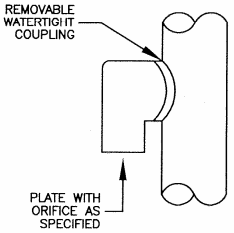
9. RESTRICTOR PLATE WITH ORIFICE AS SPECIFIED ON THESE PLANS. SPECIFIED OPENING TO BE CUT ROUND AND SMOOTH.

10. CLEANOUT/SHEAR GATE: ALUMINUM ALLOY PER B–26–26–32E OR CAST IRON ASTM A48 CLASS 308 AS REQUIRED. LIFT HANDLE EITHER SOLID OR TUBING WITH ADJUSTABLE HOOK AS REQUIRED. NEOPRENE RUBBER GASKET REQUIRED BETWEEN RISER MOUNTING FLANGE AND GATE FLANGE. MATING SURFACES OF LID AND BODY TO BE MACHINED FOR PROPER FIT. FLANGE MOUNTING BOLTS SHALL BE 3/4" DIA. STAINLESS STEEL.

11. GATE SHALL NOT OPEN BEYOND THE CLEAR OPENING BY LIMITED HINGE MOVEMENT, STOP TABS, OR SOME OTHER DEVICE.



SECTION A – A



ELBOW DETAIL

DRAWN BY
RRG

NTS

EXHIBIT 2–7
ORIFICE LOCATION
TEE RISER

EXHIBIT 2-7.DWG, 08/04/04 at 07:34

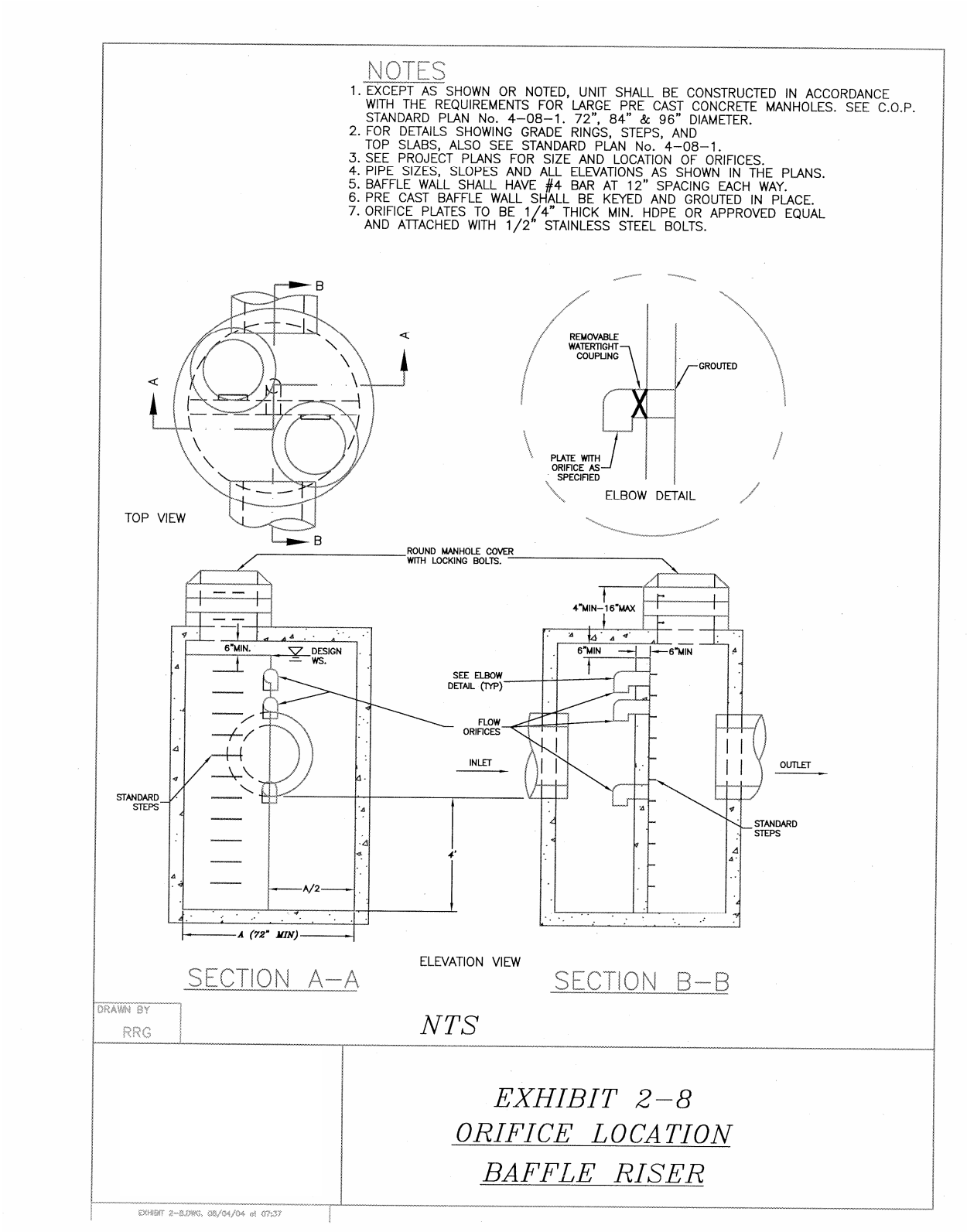
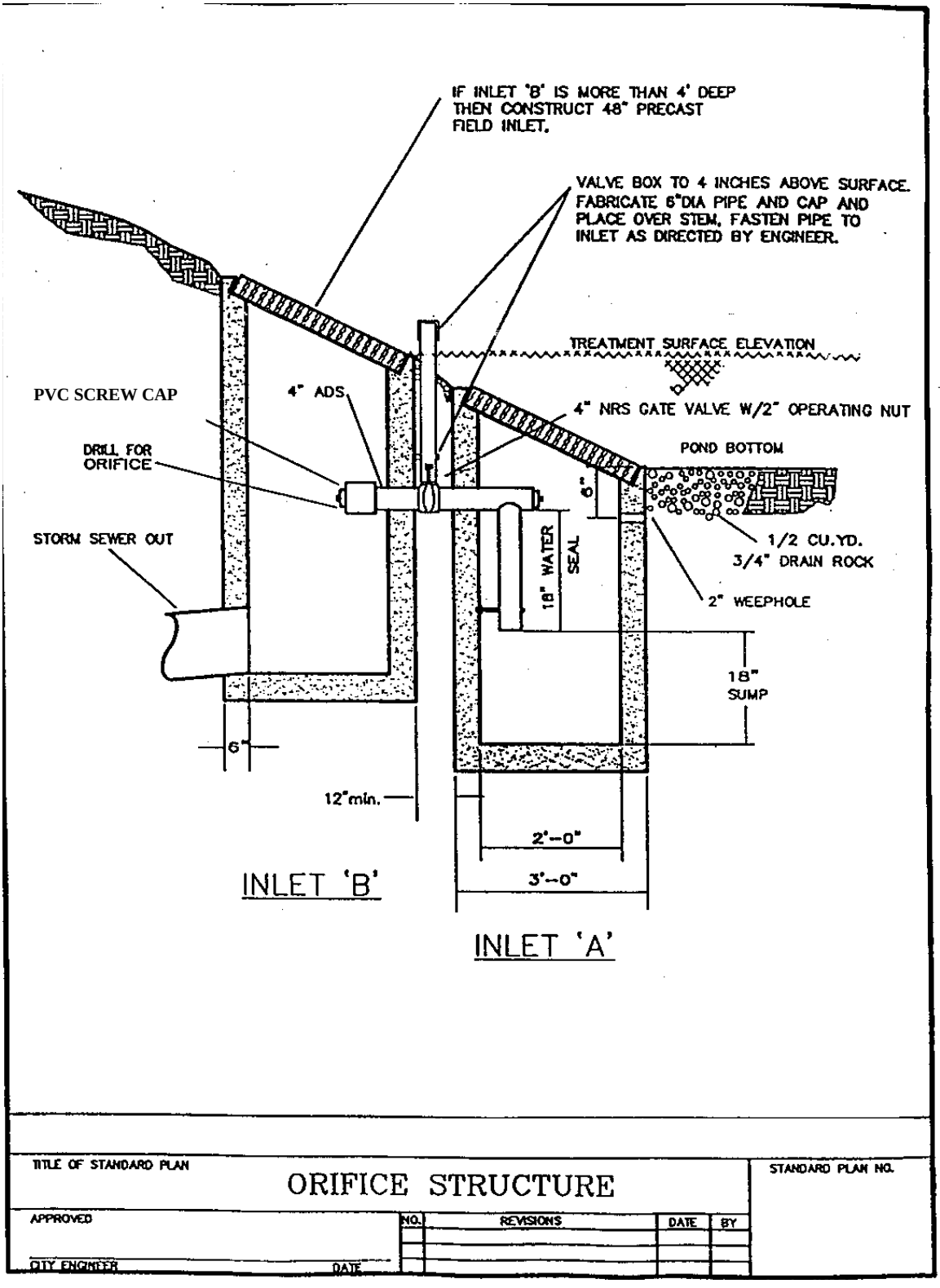

NOTES
1. EXCEPT AS SHOWN OR NOTED, UNIT SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE REQUIREMENTS FOR LARGE PRE CAST CONCRETE MANHOLES. SEE C.O.P. STANDARD PLAN No. 4-08-1. 72", 84" & 96" DIAMETER.
2. FOR DETAILS SHOWING GRADE RINGS, STEPS, AND TOP SLABS, ALSO SEE STANDARD PLAN No. 4-08-1.
3. SEE PROJECT PLANS FOR SIZE AND LOCATION OF ORIFICES.
4. PIPE SIZES, SLOPES AND ALL ELEVATIONS AS SHOWN IN THE PLANS.
5. BAFFLE WALL SHALL HAVE #4 BAR AT 12" SPACING EACH WAY.
6. PRE CAST BAFFLE WALL SHALL BE KEYED AND GROUTED IN PLACE.
7. ORIFICE PLATES TO BE 1/4" THICK MIN. HDPE OR APPROVED EQUAL AND ATTACHED WITH 1/2" STAINLESS STEEL BOLTS.
B
A
A
B
TOP VIEW
REMOVABLE WATERTIGHT COUPLING
GROUTED
PLATE WITH ORIFICE AS SPECIFIED
ELBOW DETAIL
ROUND MANHOLE COVER WITH LOCKING BOLTS.
6"MIN.
DESIGN W.S.
STANDARD STEPS
A/2
A (72" MIN)
4'
4"MIN-16"MAX
6"MIN
6"MIN
SEE ELBOW DETAIL (TYP)
FLOW ORIFICES
INLET
OUTLET
STANDARD STEPS
ELEVATION VIEW
SECTION A-A
SECTION B-B
DRAWN BY
RRG
NTS
EXHIBIT 2-8
ORIFICE LOCATION
BAFFLE RISER
EXHIBIT 2-8.DWG, 08/04/04 at 07:37

Exhibit 2-9:


IF INLET 'B' IS MORE THAN 4' DEEP
THEN CONSTRUCT 48" PRECAST
FIELD INLET.
VALVE BOX TO 4 INCHES ABOVE SURFACE.
FABRICATE 6"DIA PIPE AND CAP AND
PLACE OVER STEM, FASTEN PIPE TO
INLET AS DIRECTED BY ENGINEER.
TREATMENT SURFACE ELEVATION
PVC SCREW CAP
4" ADS
4" NRS GATE VALVE W/2" OPERATING NUT
DRILL FOR
ORIFICE
POND BOTTOM
6"
STORM SEWER OUT
18" WATER
SEAL
1/2 CU.YD.
3/4" DRAIN ROCK
2" WEEPHOLE
18"
SUMP
6"
12"min.
2'-0"
3'-0"
INLET 'B'
INLET 'A'
TITLE OF STANDARD PLAN
ORIFICE STRUCTURE
STANDARD PLAN NO.
APPROVED
CITY ENGINEER
DATE
NO.
REVISIONS
DATE
BY

Rectangular Notched Sharp Crested Weir

$$Q = C\,(L - 0.2H) * H^{1.5}$$

where:

Q= Weir discharge, cubic feet per second (cfs)
C = 3.27 + 0.40*H/P, feet
P = Height of weir bottom above downstream water surface, feet
H = Height from weir bottom to crest, feet
L = Length of weir, feet*

* For weirs notched out of circular risers, length is the portion of the riser circumference not to exceed 50 percent of the circumference.

V-Notched Sharp Crested Weir

$$Q = C_d \left(\text{Tan } \frac{\theta}{2}\right) H^{\frac{5}{2}}$$

where:

Q = Weir discharge, cfs
C_d = Contraction coefficient, feet (suggested value = 2.5 for 90 degree weir)
θ = Internal angle of notch, degrees
H = Height from weir bottom to crest, feet

2.6 ACCESS FOR OPERATIONS AND MAINTENANCE

Adequate access for operations and maintenance must be provided to all stormwater management facilities and their components. Public facilities shall have access routes at least 8 feet wide, not to exceed 10 percent in slope, and shall be located adjacent to public rights-of-way wherever feasible. Where structural surfaces are needed to support maintenance vehicles, access routes shall be constructed of gravel or other permeable paving surface where possible. Public facility vehicular access routes shall be designed for water loading.

2.7 LANDSCAPING REQUIREMENTS

Vegetation is a key element in the performance of many stormwater management facilities. Facility-specific planting requirements are given in **Section 2.9**. These requirements for design and construction are required to be covered by a 2-year warranty period.

At the end of the first year and again at the end of the 2-year warranty period, all plants that do not survive must be replaced. Establishment procedures, such as control of invasive weeds, animal and vandal damage, mulching, re-staking, watering, and mesh or tube protection replacement, shall be implemented to the extent needed to ensure plant survival.

Stormwater facilities located in the public street right-of-way are not required to use evergreen trees to meet landscaping requirements.

Where the plant material requirements of this manual and Article 23 differ, the designer shall use the larger quantity and sizes. (In calculating quantities, fractions should be rounded to the higher half-inch.)

Landscaping required by Article 23 may be counted toward meeting the facility-specific landscape requirements in this chapter if the plantings are located within the facility area. Similarly, plantings that meet the requirements in this chapter may also meet Article 23 landscape requirements.

It is critical that selected plant materials are appropriate for soil, hydrologic, and other facility and site conditions.

The design for plantings shall minimize the need for herbicides, fertilizers, pesticides, or soil amendments at any time before, during, and after construction and on a long-term basis. Plantings shall be designed to minimize the need for mowing, pruning, and irrigation.

Grass or wildflower seed shall be applied at the rates specified by the suppliers. If plant establishment cannot be achieved with seeding by the time of substantial completion of the stormwater facility portion of the project, the contractor shall plant the area with wildflower sod, plugs, container plants, or other means to complete the specified plantings and protect against erosion before water is allowed to enter the facility.

Landscaping Design and Submittal Requirements

The design must include elements that ensure landscape plant survival and overall stormwater facility functional success. Construction specifications and/or drawings need to include the following elements:

- Irrigation system to be used for the establishment period and permanent long-term. Note that public stormwater management facilities shall be designed so permanent long-term irrigation systems are not needed.

- Landscape plan showing the location of landscape elements, including size and species of all proposed plantings, and existing plants and trees to be preserved.

- Plant list/table, including scientific name, size at time of planting, quantity, type of container, evergreen or deciduous, appropriate planting season, native or non-native to region, and other information in accordance with the facility-specific planting section and landscape industry standards.

2.8 OUTFALL DESIGN

Outfalls shall be located above the downstream mean low water level, except as approved by the City. **Exhibit 2-10** shows a typical outfall layout. Concrete endwalls will be required for all exposed outfall pipes greater than 12 inches in diameter (See **Exhibit 2-13**). Publicly accessible outfalls greater than 18 inches in diameter shall include grated protection in accordance with **Exhibit 2-14**. All outfalls shall be provided with a rock splash pad or other approved erosion control/energy dissipation measures. Rock protection at outfalls from small diameter pipes shall be as follows:

RIP-RAP PAD DIMENSIONS FOR SMALL OUTFALLS
2″ Pipe: 12″ wide x 24″ long x 2″ deep, Average Stone Size = 1″
4″ Pipe: 24″ wide x 36″ long x 4″ deep, Average Stone Size = 2″
6″ Pipe: 36″ wide x 48″ long x 6″ deep, Average Stone Size = 4″

Rock protection at outfalls from pipes greater than 6 inches shall be designed in accordance with **Exhibit 2-11**, unless otherwise approved by the City. **Exhibit 2-12** shows riprap class selection. All rock protection areas shall be inter-planted with

willow stakes or other approved plantings, every two feet on-center, to increase stability, reduce erosion, provide shading, and improve aesthetics.

Engineered energy dissipaters, including stilling basins, drop pools, hydraulic jump basins, baffled aprons, and bucket aprons, are required for outfalls with velocity at design flow greater than 20 feet per second (fps). These shall be designed by a professional engineer using published references such as *Hydraulic Design of Energy Dissipaters for Culverts and Channels* (U.S. Department of Transportation, Federal Highway Administration) and other references. The construction plan submittal shall identify the design reference.

Drainageways and rivers may have steep slopes or banks and may have unstable landforms (i.e. slump). Geotechnical investigation to determine the stability of the stream or river bank, as reviewed and approved by the City Engineer, may be required for approval.

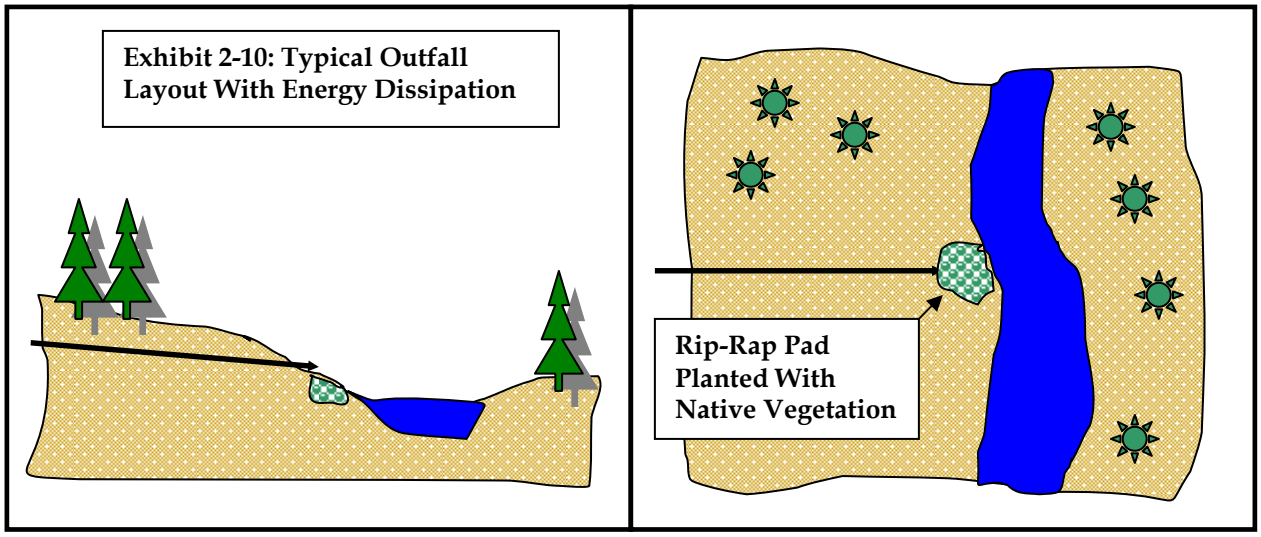


Exhibit 2-11
ROCK PROTECTION AT OUTFALLS FOR PIPES GREATER THAN 6 INCHES IN DIAMETER

Discharge Velocity at Design Flow (fps)			REQUIRED PROTECTION Minimum Dimensions				
			Type	Depth*	Width	Length**	Height
0	To	5	Riprap*	2 x (max stone size)	Diameter + 6 ft.	As calculated	Crown + 1 ft.
6	To	10	Riprap*	2 x (max stone size)	Diameter + 6 ft. or 3x dia. which-ever is greater	As calculated	Crown + 1 ft.
11	To	20	Gabion or Riprap*	2 x (max stone size)	Diameter + 6 ft. or 4x dia. which-ever is greater	As calculated	Crown +1 ft.
Over 20			Engineered Energy Dissipater Required				

* Riprap size shall be determined using the following formulae*** and the City of Grants Pass's Engineering Standards

V = Average velocity (ft/s)
Do = Pipe diameter (ft)
ds = Riprap diameter (ft)
Lsp = Apron length (ft)
depth = Thickness (ft)
Fo = $V/(g*Do)^{0.5}$

*Riprap size ds=0.25*Do*Fo (6" minimum)
Depth=2*ds (1 foot minimum)
**Apron length Lsp= Do(8+17*Log Fo)

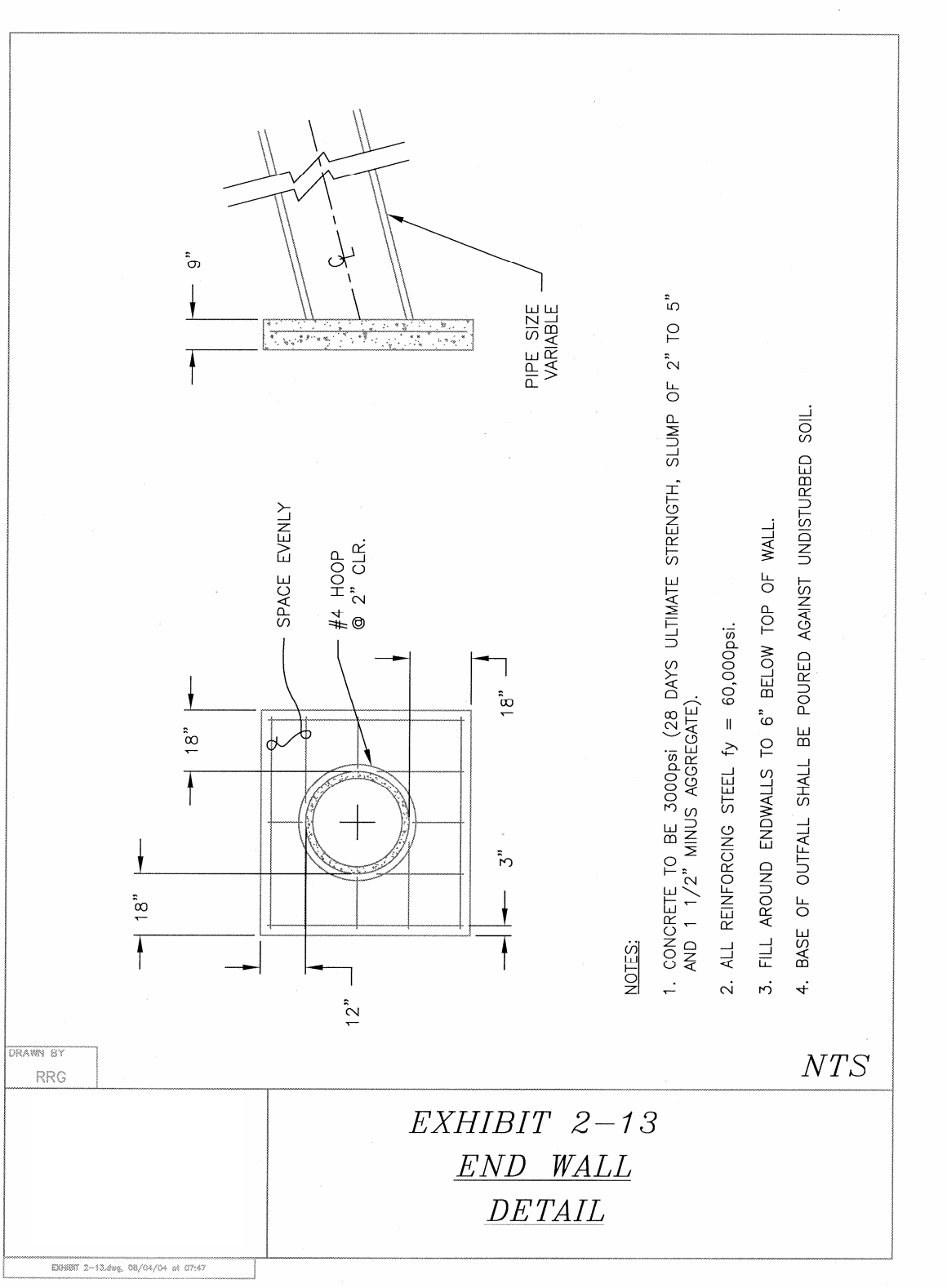
g = 32.2 ft/s^2

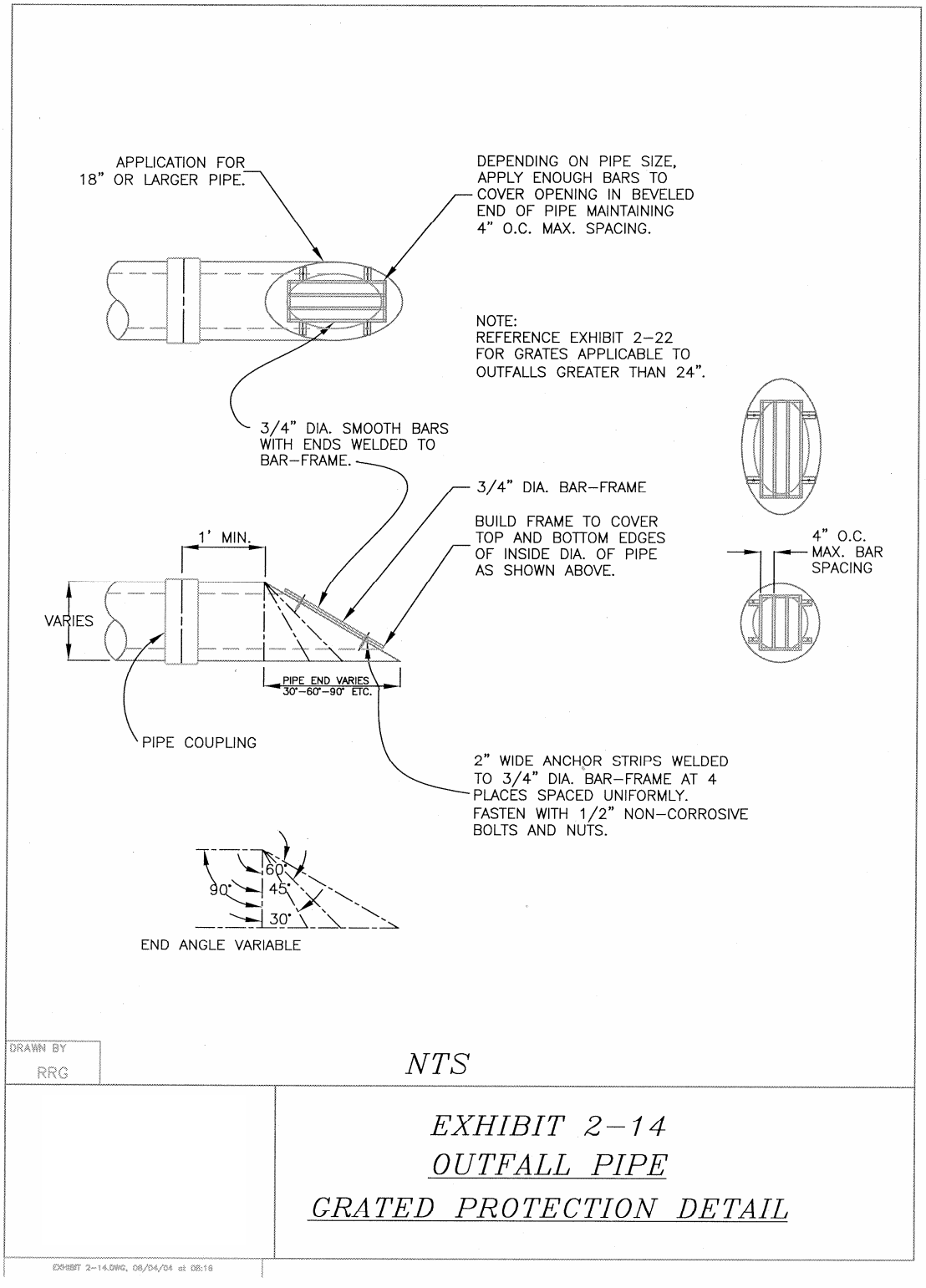
***US Army Corps of Engineers design formulas from *Erosion and Riprap Requirements at Culvert and Storm Outlets*, January 1970

Exhibit 2-12: RIPRAP CLASS SELECTION

Weight (lbs)	Spherical Size (inches)	% by Weight	Average Stone Size (inches)
Class 50			6.3
30 – 50	8.5 – 10	20	
15 – 30	6.7 – 8.5	30	
2 – 15	3.5 – 6.7	40	
0 – 2	0 – 3.5	10	
Class 100			7.6
60 – 100	10.6 – 12.8	20	
25 – 60	8.0 – 10.6	30	
2 – 25	3.5 – 8.0	40	
0 – 2	0 – 3.5	10	
Class 250			11.3
200 – 250	15.0 – 18.0	20	
100 – 200	12.0 – 15.0	30	
10 – 100	6.0 – 12.0	40	
0 – 10	0 – 6.0	10	
Class 700			15.2
500 – 700	21.5 – 24.0	20	
200 – 500	15.9 – 21.5	30	
20 – 200	7.4 – 15.9	40	
0 – 20	0 – 7.4	10	
Class 2000			21.7
1400 – 2000	30.4 – 34.0	20	
700 – 1400	24.0 – 30.4	30	
40 – 700	9.3 – 24.0	40	
0 – 40	0 – 9.3	10	

Reference: Erosion and Riprap Requirements at Culverts and Storm-Drain Outlets
U.S. Army Engineers, Jan 1970


9"
PIPE SIZE
VARIABLE
SPACE EVENLY
#4 HOOP
@ 2" CLR.
18"
18"
18"
3"
12"
NOTES:
1. CONCRETE TO BE 3000psi (28 DAYS ULTIMATE STRENGTH, SLUMP OF 2" TO 5"
AND 1 1/2" MINUS AGGREGATE).
2. ALL REINFORCING STEEL fy = 60,000psi.
3. FILL AROUND ENDWALLS TO 6" BELOW TOP OF WALL.
4. BASE OF OUTFALL SHALL BE POURED AGAINST UNDISTURBED SOIL.
DRAWN BY
RRG
NTS
EXHIBIT 2-13
END WALL
DETAIL
EXHIBIT 2-13.dwg, 08/04/04 at 07:47

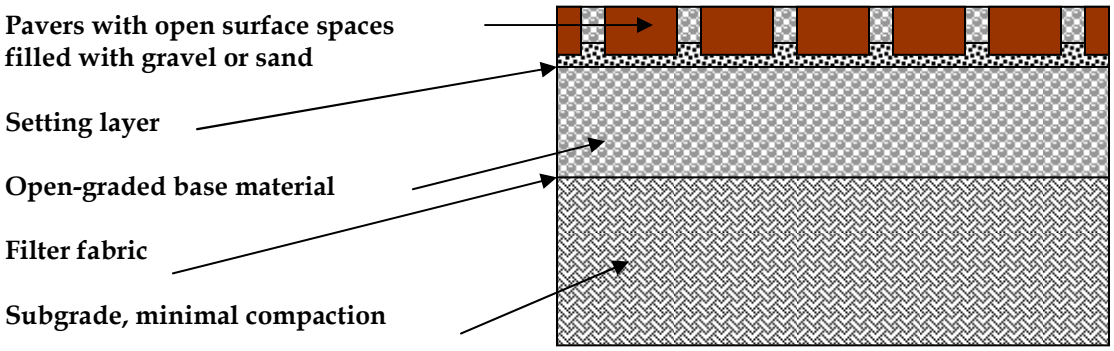

APPLICATION FOR
18" OR LARGER PIPE.
DEPENDING ON PIPE SIZE,
APPLY ENOUGH BARS TO
COVER OPENING IN BEVELED
END OF PIPE MAINTAINING
4" O.C. MAX. SPACING.
NOTE:
REFERENCE EXHIBIT 2-22
FOR GRATES APPLICABLE TO
OUTFALLS GREATER THAN 24".
3/4" DIA. SMOOTH BARS
WITH ENDS WELDED TO
BAR-FRAME.
3/4" DIA. BAR-FRAME
BUILD FRAME TO COVER
TOP AND BOTTOM EDGES
OF INSIDE DIA. OF PIPE
AS SHOWN ABOVE.
4" O.C.
MAX. BAR
SPACING
1' MIN.
VARIES
PIPE END VARIES
30°-60°-90° ETC.
PIPE COUPLING
2" WIDE ANCHOR STRIPS WELDED
TO 3/4" DIA. BAR-FRAME AT 4
PLACES SPACED UNIFORMLY.
FASTEN WITH 1/2" NON-CORROSIVE
BOLTS AND NUTS.
60°
90°
45°
30°
END ANGLE VARIABLE
DRAWN BY
RRG
NTS
EXHIBIT 2-14
OUTFALL PIPE
GRATED PROTECTION DETAIL
EXHIBIT 2-14.DWG, 08/04/04 at 08:16

2.9 FACILITY DESIGN CRITERIA

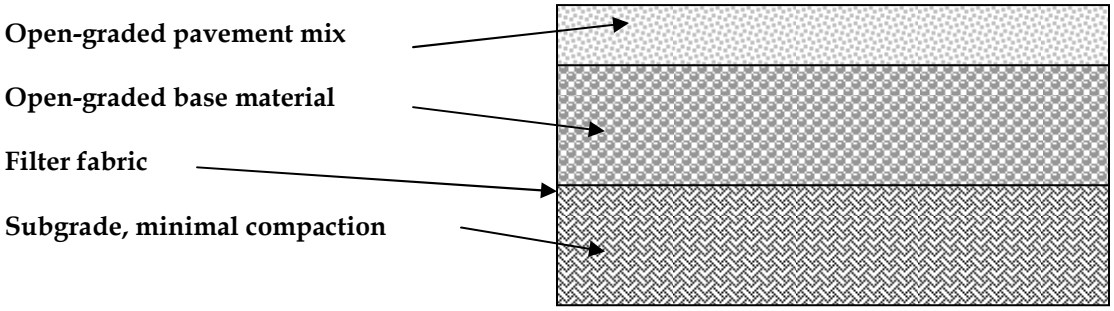
Stormwater Management Design Criteria For:

2.9.1 Pervious Pavement

Pervious Concrete Block or "Paver" Systems



Pervious (Open Graded) Concrete and Asphalt Mixes



Stormwater Management Goals Achieved	Acceptable Sizing Methodologies
√ Impervious Area Reduction	
√ Pollution Reduction……..	SIM
√ Flow Control……	SIM

SIM=Simplified Approach, PRES= Presumptive Approach, PERF= Performance Approach

Notes: 1) This facility is an impervious surface reduction technique. It is applicable for use in parking lots, driveways, and in some cases streets.

Description: There are many types of pervious pavement on the market today. Numerous products and design approaches are available, including special asphalt paving; manufactured products of concrete, plastic, and gravel; paving stones; and brick. It may be used for walkways, patios, plazas, driveways, parking lots, and some portions of streets, subject to compliance with building codes and City Administrative Rules. To receive credit, the material must be installed and maintained to manufacturer's specifications. These materials may not be allowed in certain areas (see Chapter 4.0 for restrictions). A professional engineer, registered in the state of Oregon must design pervious pavement systems that will be supporting vehicular traffic. For EPA's "Porous Pavement Phase I Design and Operational Criteria" (EPA-600/2-80-135), go to:
http://www.epa.gov/ednnrmrl/publications/reports/epa600280135/epa600280135.htm.

Design Considerations: When designing pervious pavement systems, the infiltration rate of the native soil is a key element in determining the depth of base rock for the storage of stormwater, or for determining whether an underdrain system is appropriate. Traffic loading and design speed are important considerations in determining which type of pervious pavement is applicable. Pedestrian ADA accessibility, aesthetics, and maintainability are also important considerations, depending on pavement use. Pervious pavement should have 30% voids. The diameter of the material should get larger as you move down in through the different material.

Construction Considerations: Installation procedures are vital to the success of pervious pavement projects, particularly pervious asphalt and concrete pavement mixes. The subgrade cannot be overly compacted with the inclusion of fine particulates or the void ratio critical to providing storage for large storm events will be lost. Weather conditions at the time of installation can affect the final product. Extremely

high or low temperatures should be avoided during construction of pervious asphalt and concrete pavements.

Design Requirements:

Soil Suitability: Pervious pavement systems are appropriate for all soil types, but will require underdrain systems to an approved stormwater disposal point (per Section 1.4) for soils that do not infiltrate well (less than 0.5 inches per hour, generally NRCS soil types C and D). There shall be no less than three feet of undisturbed infiltration medium between the bottom of the base rock and any impervious layer (i.e. hardpan, solid rock, high groundwater levels, etc.), unless an underdrain system is used.

Dimensions and Slopes: Minimum/ maximum dimensions and other specifications are product-specific and shall comply with manufacturer's recommendations. Slopes shall be less than 10% in all cases. Pervious pavement should have 30% voids. The diameter of the material should get larger as you move down in through the different material.

Setbacks: Not applicable.

Sizing: Pervious pavement systems are not considered to be impervious surfaces, and therefore do not trigger pollution reduction and flow control requirements. A high-flow overflow or underdrain system must be provided.

Limitations: Pervious pavements shall not be used on sites with a likelihood of high oil and grease concentrations. These site uses include vehicle wrecking or impound yards, fast food establishments, automotive repair and sales, and parking lots that receive a high number of average daily trips (> 1,000).

Checklist of minimal information to be shown on the permit drawings:

(Additional information may be required on the drawings during permit review, depending on individual site conditions.)

1) Facility dimensions and setbacks from property lines and structures
2) Profile view of facility, including typical cross-sections with dimensions
3) Pervious pavement materials and installation procedure specifications
4) Subgrade and base course specifications
5) Filter fabric specification (if applicable)
6) All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection

Inspection requirements and schedule: The following table shall be used to determine which stormwater facility components require City inspection, and when the inspection shall be requested:

Facility Component	Inspection Requirement
Subgrade	Call for inspection
Filter fabric (if applicable)	
Underdrain piping (if applicable)	Call for inspection
Base rock	
Pervious pavement installation	Call for inspection

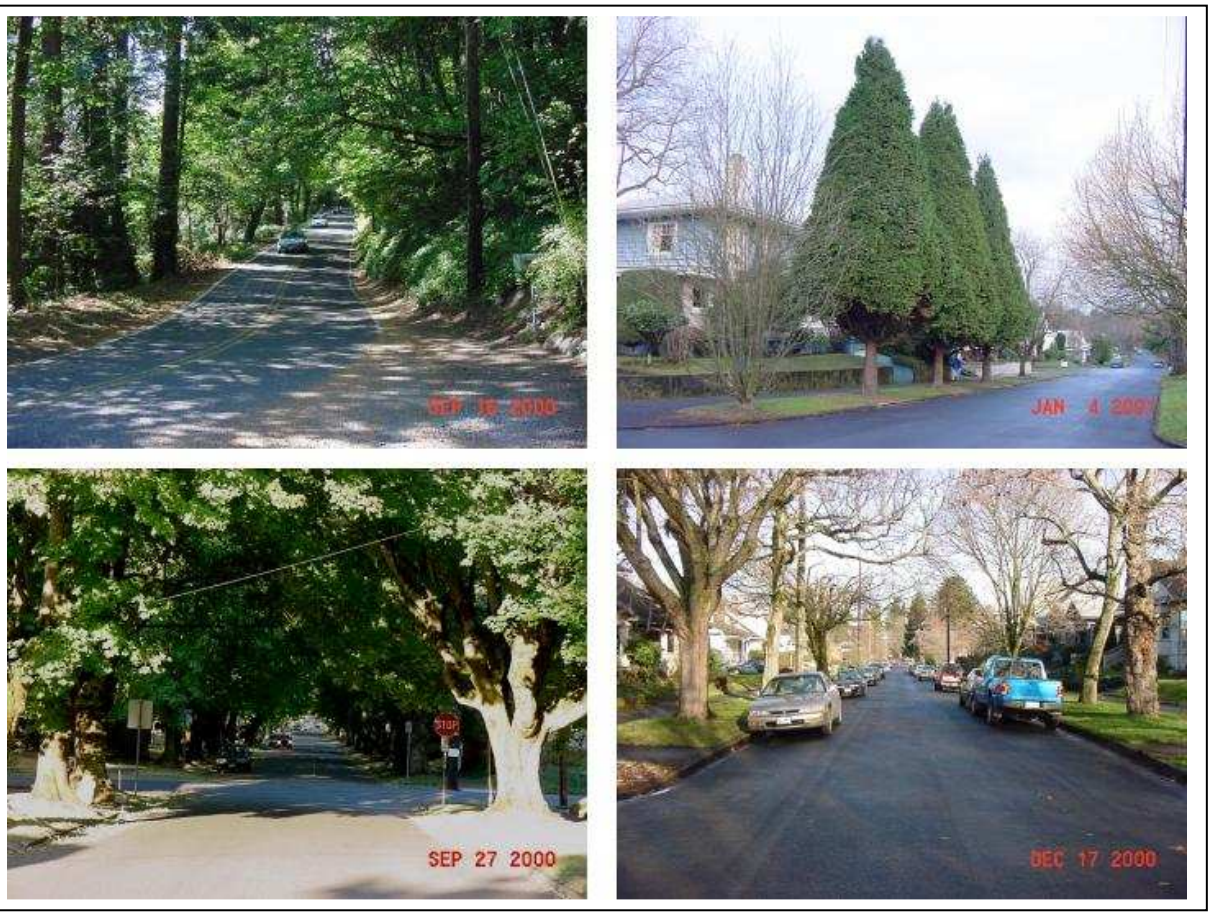
Operations and Maintenance requirements: See **Chapter 3.0**.

* Link to pervious pavement O&M form

Additional photos and drawings:

* Link to pervious pavement photos
* Link to pervious pavement drawings
    * Link to pervious Asphalt drawing
    * Link to pervious concrete drawing
    * Link to brick drawing
    * Link to cobble drawing
    * Link to crushed aggregate drawing
    * Link to natural stone drawing
    * Link to turf block drawing
    * Link to unit pavers on sand drawing

2.9.2 Tree Credits



Stormwater Management Goals Achieved	Acceptable Sizing Methodologies
√ Impervious Area Reduction……..	SIM
√ Pollution Reduction……..……..	SIM
√ Flow Control…….……	SIM

SIM=Simplified Approach, PRES= Presumptive Approach, PERF= Performance Approach

Notes: 1) This facility intercepts rainfall and provides shade for impervious surfaces. Trees may only receive credit against the construction of ground-level impervious surfaces.

Description: Trees intercept precipitation and provide several stormwater management benefits:

- **Flow control:** Trees hold water on the leaves and branches and allow it to evaporate, retaining flow and dissipating the energy of runoff. These functions are most measurable for storms of less than 0.5 inches over 24 hours. While deciduous trees are not as effective during winter months, evergreen trees are effective year round for these smaller storms and portions of larger storms. Generally, large trees with small leaves are the most efficient rainfall interceptors. Trees also facilitate stormwater infiltration and groundwater recharge.

- **Pollution reduction/ stormwater cooling:** Trees can provide shade over large areas of impervious surface. This provides two direct benefits. First, the hard surface is protected from direct solar exposure, which reduces heat gain. The less heat gain there is in pavement, the less heat is absorbed by stormwater as it flows over the surface. Second, by shading pavement, the trees help reduce or minimize air temperature increases caused by the hot pavement. Cooler air may help prevent stream temperature increases associated with air temperatures.

New trees planted within 25 feet of ground-level impervious surfaces are eligible for stormwater management credit. 100 square feet of credit is given for new deciduous trees, and 200 square feet of credit is given for new evergreen trees (See minimum sizes below). Stormwater management credits also apply to existing trees kept on a site if the trees' canopies are within 25 feet of ground-level impervious surfaces. The credit is the square-footage equal to one-half of the existing tree canopy. No credit will be given for existing trees within an environmental zone. For sites creating over 3,500 square-feet of new impervious surface (1,400 square feet of mitigated impervious surface area), no more than 10% can be mitigated through the use of trees.

Trees used for stormwater management credit shall be clearly labeled on permit drawings. A note shall be included on the permit drawings that calls for City inspection after the tree has been planted, or in the case of existing tree canopy, after the site grading has been completed.

NEW EVERGREEN AND DECIDUOUS TREES:

Trees shall be maintained and protected on the site after construction and for the life of the development (50-100 years or until any approved redevelopment occurs in the future). During the life of the development, trees approved for stormwater credit shall not be removed without approval from the City. Trees that are removed or die shall be replaced within 6 months with like species. Trees may be pruned for safety purposes only; however, if a tree is planted near a building, pruning to protect the structure is recommended and allowed.

The trees selected shall be suitable species for the site conditions and the design intent. Trees should be relatively self-sustaining and long-lived. Native conifers are highly encouraged, as many of these trees naturally grow in harsh/rocky conditions and do not require require long-term irrigation. New deciduous trees must be at least 2 caliper inches and new evergreen trees must be at least 6 feet tall to receive simplified approach credit. Trees planted to meet stormwater facility planting requirements cannot also receive simplified approach credit.

Approved Trees

The following tree and arborescent shrub* species are approved outright for use as simplified approach tree credits. Other species may be given credit, as approved by the City.

Acer macrophyllum	Juniperus occidentalis*	Quercus garryana
Alnus rubra	Libocendrus decurrens	Rhamnus purshiana
Arbutus menziesii	Pinus contorta	Sequoia sempervirens
Castanopsis chrysophylla*	Pinus monticola	Thuja plicata
Chamacyparis lawsoniana	Pinus ponderosa	Tsuga heterophylla
Cornus nuttallii	Pseudotsuga menziesii	Umbellularia californica
Fraxinus latifolia	Quercus chrysolepis*	

Underlined species s are not recommended for use as street trees (23.078). Consult with the City prior to using these trees for mitigation.

EXISTING TREES:

Mature evergreen and deciduous trees can have significant benefits in addition to stormwater management. They already provide habitat for urban wildlife, energy and cost conservation, aesthetics, visual screens, heritage value, windbreaks, and recreation.

The stormwater credit applies to existing trees of 4-inch caliper or larger. Credit is based on one-half of the square footage of the tree canopy, measured within the drip-line. An existing tree for which protection is required by City code is not eligible for credits.

Protection during construction shall be in the form of minimizing disruption of the root system. Construction shall not encroach within a space measured 10 feet outside of the drip line to the tree trunk, unless the City approves exemptions to this requirement. The applicant will have to provide documentation required by the City to ensure the tree will remain healthy after construction and during the life of the project. During the life of the development, trees approved for stormwater credit shall not be removed without approval from the City. Stormwater management functions of any removed trees shall be replaced on the site with other trees or stormwater management approaches. Trees that die shall be replaced within 6 months. Trees may be pruned for safety purposes only; however, if a tree is near a building, pruning to protect the structure is recommended and allowed.

Checklist of minimal information to be shown on the permit drawings:

1) Trees to be given stormwater management credit shall be clearly labeled as such, with the size and species included.
2) Approximate setbacks from property lines and structures shall be shown.
3) Temporary irrigation measures shall be shown, if applicable.
4) Form SIM must be submitted, clearly showing that less than 10% of the impervious area is being mitigated for with tree credits if the project impervious area exceeds 3,500 square feet.

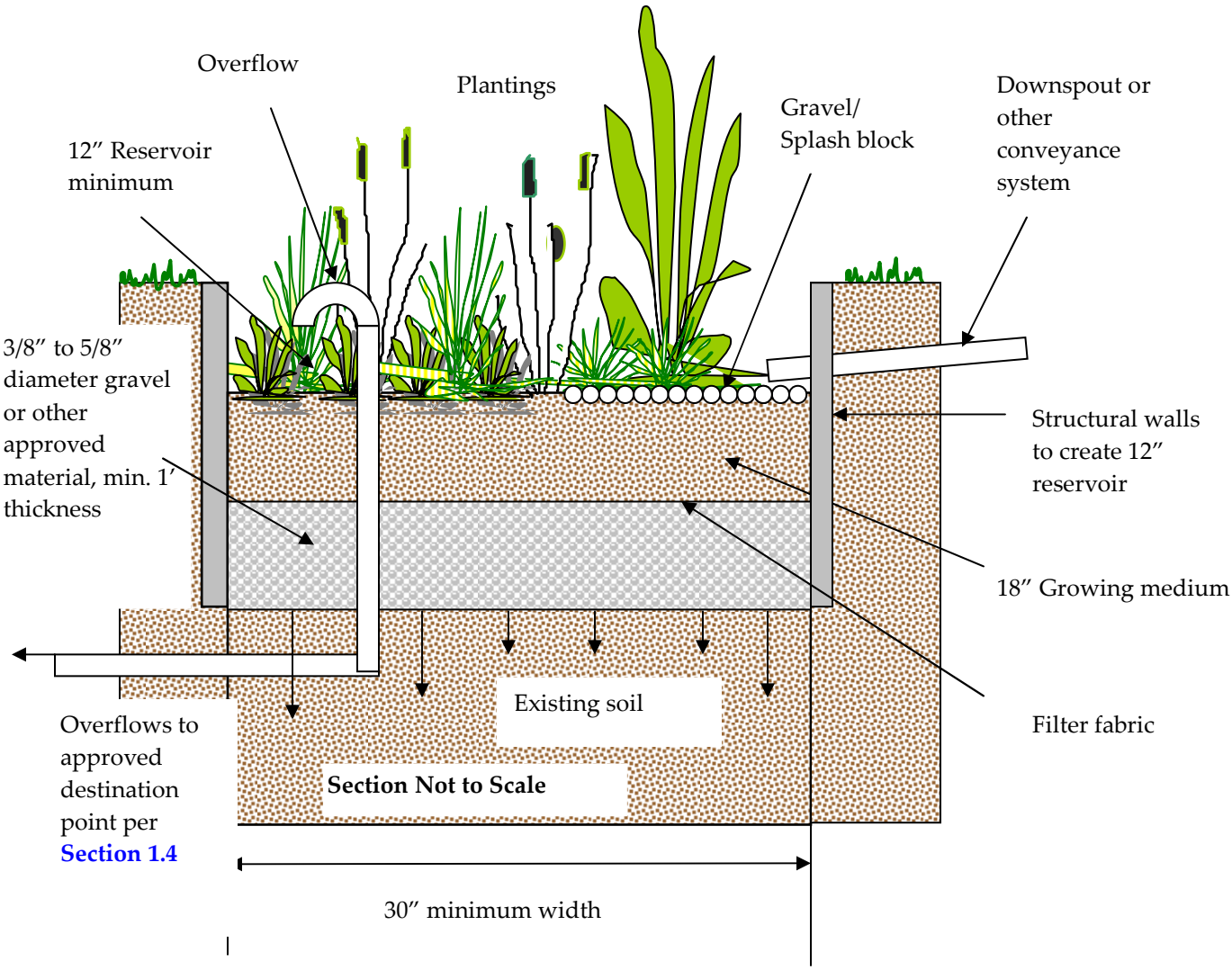
Operations and Maintenance requirements: See **Chapter 3.0**.

*** Link to new tree O&M form**

Additional photos:

*** Link to tree photos**

2.9.3 Infiltration Planter



Stormwater Management Goals Achieved	Acceptable Sizing Methodologies
√ Pollution Reduction……..	SIM, PERF[1]
√ Flow Control…….……	SIM
√	

Notes: 1) The Performance Approach may be used to downsize the Simplified Approach sizing factor when the only goal is pollution control.

Description: Infiltration planters are structural landscaped reservoirs used to collect, filter, and infiltrate stormwater runoff, allowing pollutants to settle and filter out as the water percolates through the planter soil and infiltrates into the ground. In addition to providing pollution reduction, flow rates and volumes can also be managed with infiltration planters. Planters can be used to help fulfill a site's required landscaping area requirement and should be integrated into the overall site design. Numerous design variations of shape, wall treatment, and planting scheme can be used to fit the character of a site.

Design Considerations: When designing infiltration planters, the infiltration rate of the native soil is a key element in determining size and viability.

Construction Considerations: Infiltration planter areas should be clearly marked before site work begins to avoid soil disturbance during construction. No vehicular traffic, except that specifically used to construct the facility, should be allowed within 10 feet of planter areas.

Design Requirements:

Soil Suitability: Infiltration planters are appropriate for soils with a minimum infiltration rate of 2 inches per hour (NRCS soil types A and B). There shall be no less than three feet of undisturbed infiltration medium between the bottom of the facility and any impervious layer (i.e. hardpan, solid rock, high groundwater levels, etc.) Topsoil shall be used within the top 18 inches of the facility.

Dimensions and Slopes: Facility storage depth must be at least 12 inches, unless a larger-than-required planter square-footage is used. Minimum planter width is 30 inches. Planters shall be constructed without slope.

Setbacks: Required setback from property lines is 5 feet, and 10 feet from building foundations. Proposed variances to this standard must request an exception.

Planter Walls: Planter walls shall be made of stone, concrete, brick, wood, or other durable material. Chemically treated wood that can leach out toxic chemicals and contaminate stormwater shall not be used.

Sizing: Individual infiltration planters sized with the simplified approach shall be designed to receive less than 15,000 square-feet of impervious area runoff. For these projects, a simplified approach sizing factor of 0.07 may be used to receive credit for pollution and flow control. In cases when pollution reduction is the only stormwater management goal, the performance approach may be used in conjunction with a measured infiltration rate to downsize the simplified approach sizing factor. Planters shall be designed to pond water for less than 12 hours after each storm event.

Landscaping: Plantings shall be designed at the following quantities per **100** square feet of facility area. Facility area is equivalent to the area of the planter calculated from Form SIM.

4 - Large shrubs/small trees	3-gallon containers or equivalent.
6 - Shrubs/large grass-like plants	1-gallon containers or equivalent

Ground cover plants: 1 per 12 inches on center, triangular spacing, for the ground cover planting area only, unless seed or sod is specified. Minimum container: 4-inch pot. At least 50 percent of the facility shall be planted with grasses or grass-like plants.

Note: Tree planting is not required in planters, but is encouraged where practical. Tree planting is also encouraged near planters.

***Link to Flow-Through Planter Landscaping Plan Example**
***Link to Planter Recommended Plants**

Checklist of minimal information to be shown on the permit drawings:

(Additional information may be required on the drawings during permit review, depending on individual site conditions.)

1) Facility dimensions and setbacks from property lines and structures
2) Profile view of facility, including typical cross-sections with dimensions
3) Planter wall material and waterproofing membrane specification
4) Growing medium specification
5) Drain rock specification
6) Filter fabric specification
7) All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection
8) Landscaping plan

Inspection requirements and schedule: The following table shall be used to determine which stormwater facility components require City inspection, and when the inspection shall be requested:

Facility Component	Inspection Requirement
Planter grading/ excavation	
Structural components/ liner	Call for inspection
Piping	Call for inspection
Drain rock	
Filter fabric	
Growing medium	
Plantings	Call for inspection

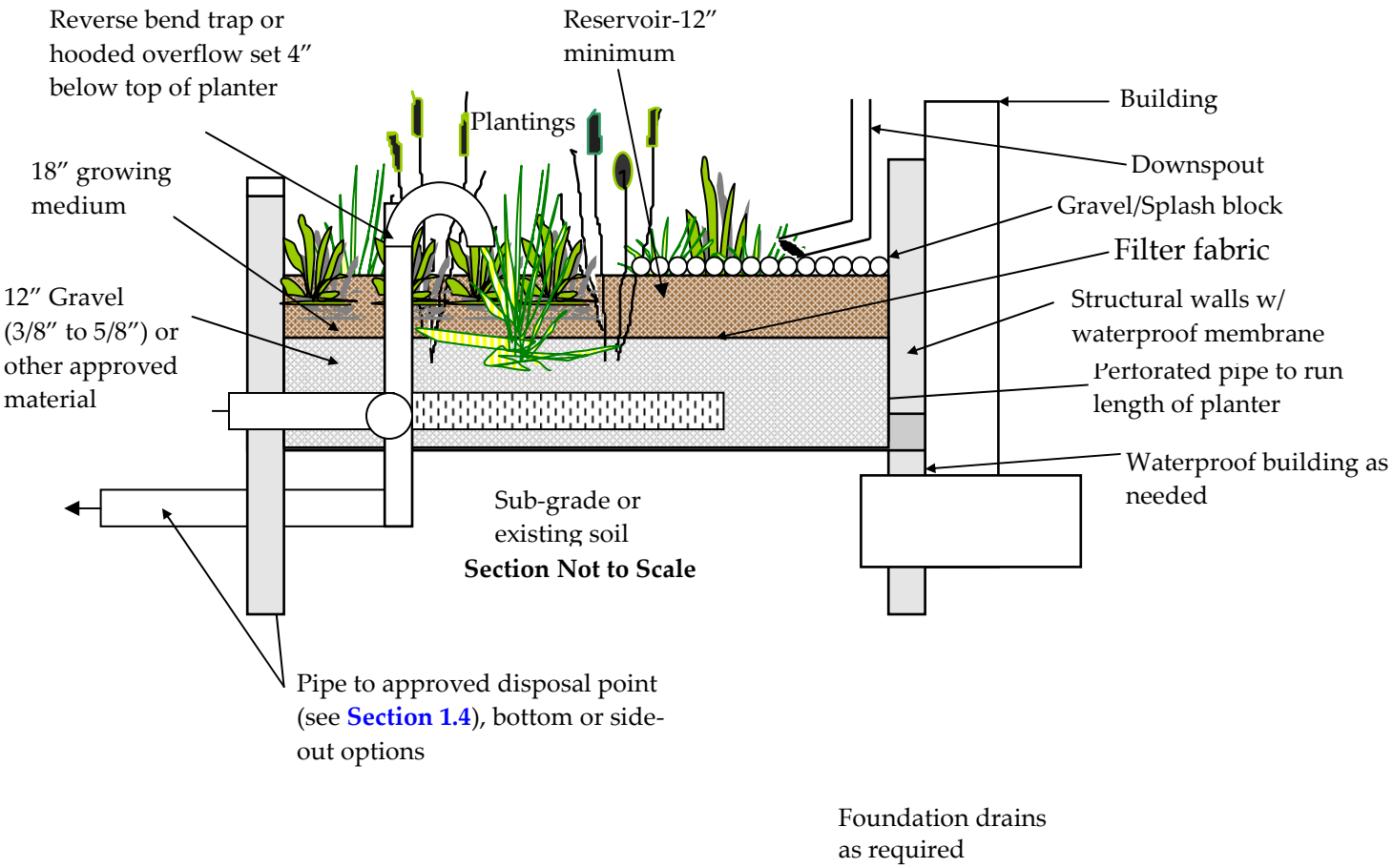
Operations and Maintenance requirements: See **Chapter 3.0**.

*** Link to infiltration planter O&M form**

Additional photos and drawings:

*** Link to infiltration planter photos**
*** Link to infiltration planter drawings**

2.9.4 Flow-Through Planter



Stormwater Management Goals Achieved	Acceptable Sizing Methodologies
√ Pollution Reduction	SIM, PERF[1]
√ Flow Control	SIM

SIM=Simplified Approach, PRES= Presumptive Approach, PERF= Performance Approach

Notes: 1) The Performance Approach may be used to downsize the simplified approach sizing factor when the only goal is pollution reduction. Flow-through planters may be designed to manage runoff from rooftops, and if submerged into the ground, parking lots and streets in some cases.

Description: Flow-through planters are structural landscaped reservoirs used to collect and filter stormwater runoff, allowing pollutants to settle and filter out as the water percolates through the planter soil. In addition to providing pollution reduction, flow rates and volumes can also be managed with flow-through planters. Planters should be integrated into the overall site design and can be used to help fulfill a site's required landscaping area requirement. Numerous design variations of shape, wall treatment, and planting scheme can be used to fit the character of a site. Because they include a waterproof lining, flow-through planters are extremely versatile and can be used next to foundation walls, adjacent to property lines (if less than 30" in height), or on slopes. An overflow to an approved conveyance will be required.

Design Considerations: When designing flow-through planters, the structural walls can often times be incorporated with building foundation plans.

Construction Considerations: Special attention needs to be paid to the planter waterproofing if constructed adjacent to building structures.

Design Requirements:

Soil Suitability: **Flow-through planters are appropriate for all soil types. Topsoil shall be used within the top 18 inches of the facility.**

Dimensions and Slopes: Facility storage depth must be at least 12 inches, unless a larger-than-required planter square-footage is used. Minimum planter width is 18 inches. Planter slopes shall be less than 0.5%.

Setbacks: Required setback from property lines is 5 feet, unless the planter height is less than 30 inches.

Planter Walls: Planter walls shall be made of stone, concrete, brick, or wood. Chemically treated wood that can leach out toxic chemicals and contaminate stormwater shall not be used.

Sizing: Individual flow-through planters sized with the simplified approach shall be designed to receive less than 15,000 square-feet of impervious area runoff. For these projects, a simplified approach sizing factor of 0.07 may be used to receive credit for pollution reduction and flow control. A high-flow overflow must be provided to an approved disposal point. In cases when pollution reduction is the only stormwater management goal, the performance approach may be used to downsize the simplified approach sizing factor. Planters shall be designed to pond water for less than 12 hours after each storm event.

Landscaping: Plantings shall be designed at the following minimum quantities per **100** square feet of facility area. Facility area is equivalent to the area of the planter calculated from Form SIM.

4 - Large shrubs/small trees	3-gallon containers or equivalent.
6 - Shrubs/large grass-like plants	1-gallon containers or equivalent

Ground cover plants:	1 per 12 inches on center, triangular spacing, for the ground cover planting area only, unless seed or sod is specified. Minimum container: 4-inch pot. At least 50 percent of the facility shall be planted with grasses or grass-like plants.

Note: Tree planting is not required in planters, but is encouraged where practical. Tree planting is also encouraged near planters.

***Link to Flow-Through Planter Landscaping Plan Example**
***Link to Planter Recommended Plants**

Checklist of minimal information to be shown on the permit drawings:

(Additional information may be required on the drawings during permit review, depending on individual site conditions.)

1) Facility dimensions and setbacks from property lines and structures
2) Profile view of facility, including typical cross-sections with dimensions
3) Planter wall material and waterproofing membrane specification
4) Growing medium specification
5) Drain rock specification
6) Filter fabric specification
7) All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection
8) Landscaping plan

Inspection requirements and schedule: The following table shall be used to determine which stormwater facility components require City inspection, and when the inspection shall be requested:

Facility Component	Inspection Requirement
Planter grading/ excavation	
Structural components/ liner	Call for inspection
Piping	Call for inspection
Drain rock	
Filter fabric	
Growing medium	
Plantings	Call for inspection

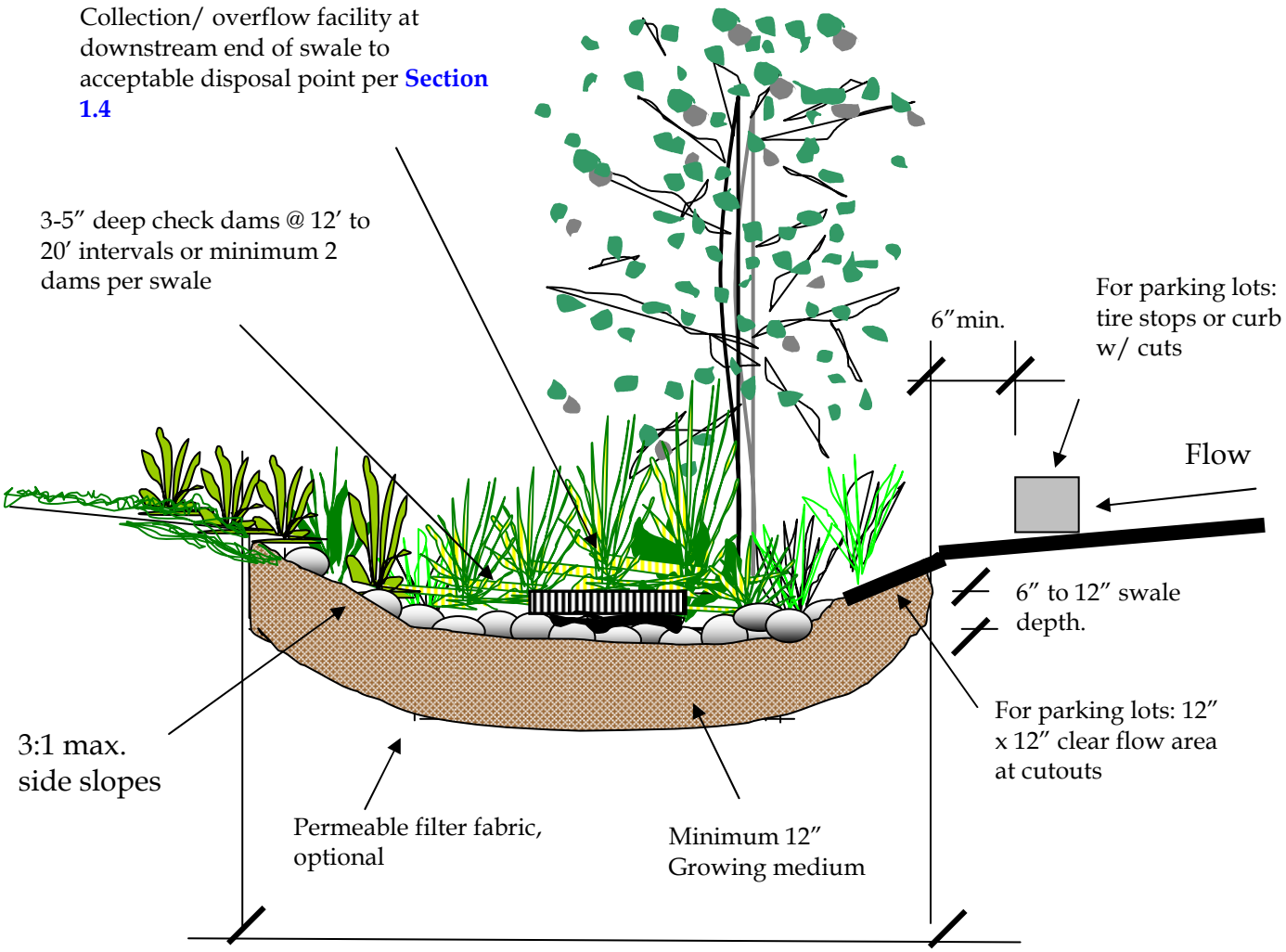
Operations and Maintenance requirements: See **Chapter 3.0**.

*** Link to flow-through planter O&M form**

Additional photos and drawings:

*** Link to flow-through planter photos**
*** Link to flow-through planter drawings**

2.9.5 Vegetated Swale



Stormwater Management Goals Achieved	Acceptable Sizing Methodologies
√ Pollution Reduction……..	SIM, PERF[1]
√ Flow Control…….……	SIM
√	

Notes: 1) The performance approach may be used to downsize the simplified approach sizing factor when the only goal is pollution reduction. Vegetated swales can be used to manage runoff from parking lots, rooftops, and private streets. For public street runoff, the street swale criteria must be used. .

Description: Vegetated swales are long narrow landscaped depressions used to collect and convey stormwater runoff, allowing pollutants to settle and filter out as the water infiltrates into the ground or flows from one bay to the next through the facility. In addition to providing pollution reduction, flow rates and volumes can also be managed with vegetated swales, as check dams are provided every 12 to 20 feet to slow and pool water. Swales should be integrated into the overall site design and can be used to help fulfill a site's required landscaping area requirement.

Design Considerations: When designing vegetated swales, slopes and depth should be kept as mild as possible to avoid safety risks, improve aesthetics, and prevent erosion within the facility.

Construction Considerations: Vegetated swale areas should be clearly marked before site work begins to avoid soil disturbance and compaction during construction. No vehicular traffic, except that specifically used to construct the facility, should be allowed within 10 feet of swale areas.

Design Requirements:

Soil Suitability: Vegetated swales are appropriate for all soil types. Topsoil shall be used within the top 12 inches of the facility, or the soil shall be amended per Appendix F to support plant growth.

Dimensions and Slopes: Facility storage depth may vary from 6 to 12 inches. Maximum side slopes are 3 horizontal to 1 vertical. Minimum flat bottom width is 2 feet for private swales, and 4 feet for public swales. Maximum longitudinal slope is 6%.

Setbacks: Required setback from centerline of swale to property lines is 5 feet, and 10 feet from building foundations unless lined with impermeable fabric or approved by the City Engineer and City Planning.

Sizing: Vegetated swales sized with the Simplified Approach shall be designed to receive less than 15,000 square-feet of impervious area runoff. For these projects, a simplified approach sizing factor of 0.09 may be used to receive credit for pollution reduction and flow control. A high-flow by-pass mechanism will not be required in these cases, but a high-flow overflow must be provided at the downstream end of the swale to an approved disposal point. In cases when pollution reduction is the only stormwater management goal, the performance approach may be used in conjunction with a measured infiltration rate to downsize the simplified approach sizing factor.

Check Dams: Check dams shall be constructed of durable, non-toxic materials such as rock, brick, or concrete, or soil by integrating them into the grading of the swale. Check dams shall be 12 inches in length, by the width of the swale, by 3 to 6 inches in height.

Landscaping: Vegetation helps improve infiltration functions, protects from rain and wind erosion, and enhances aesthetic conditions. The "facility area" is equivalent to the area of the swale, including bottom and side slopes, as calculated from Form SIM. Minimum plant material quantities per 100 square feet of facility area are as follows:

1 - Evergreen or deciduous tree (planted around the perimeter of the swale):

Evergreen trees:	Minimum height: 6 feet
Deciduous trees:	Minimum caliper: 1 ½ inches at 6 inches above base.
4 - Large shrubs/small trees:	3-gallon containers or equivalent.
6 - Shrubs/large grass-like plants:	1-gallon containers or equivalent

Ground cover plants: 1 per 12 inches on center, triangular spacing, for the ground cover planting area only, unless seed or sod is specified. Minimum container: 4-inch pot. At least 50 percent of the facility shall be planted with grasses or grass-like plants.

Wildflowers, native grasses, and ground covers used for City maintained facilities shall be designed to not require mowing. Where mowing cannot be avoided, facilities shall be designed to require mowing no more than once annually. Turf and lawn areas are not allowed for City maintained facilities; any exceptions will require City approval.

Checklist of minimal information to be shown on the permit drawings:

(Additional information may be required on the drawings during permit review, depending on individual site conditions.)

1) Facility dimensions and setbacks from property lines and structures
2) Profile view of facility, including typical cross-sections with dimensions
3) Growing medium specification
4) Filter fabric specification (if applicable)
5) All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection
6) Landscaping plan

Inspection requirements and schedule: The following table shall be used to determine which stormwater facility components require City inspection, and when the inspection shall be requested:

Facility Component	Inspection Requirement
Swale grading	Call for inspection
Piping	Call for inspection
Filter fabric (if applicable)	
Growing medium	
Plantings	Call for inspection

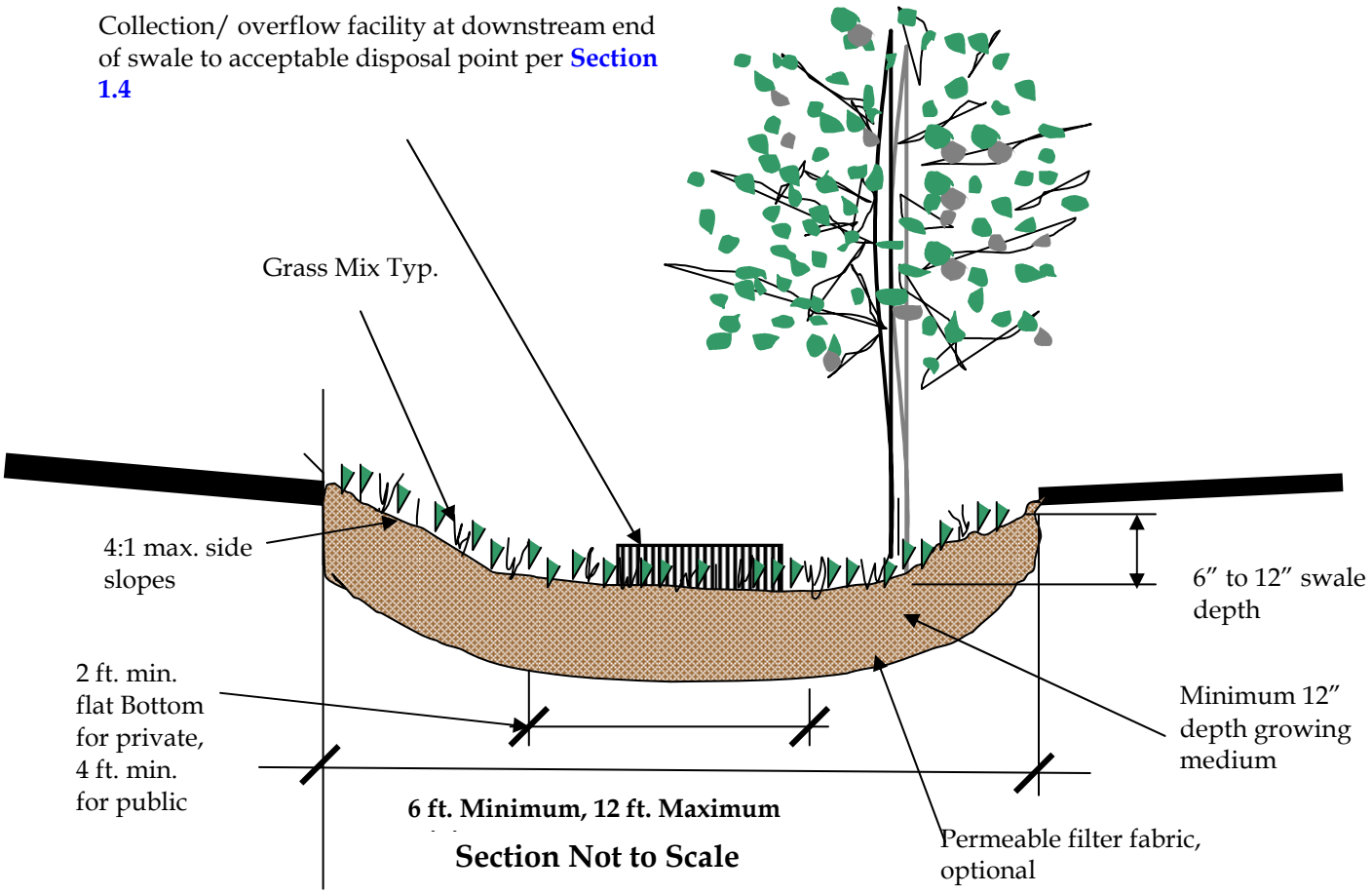
Operations and Maintenance requirements: See **Chapter 3.0**.

*** Link to vegetated swale O&M form**

Additional photos and drawings:

*** Link to vegetated swale photos**
*** Link to vegetated swale drawings**

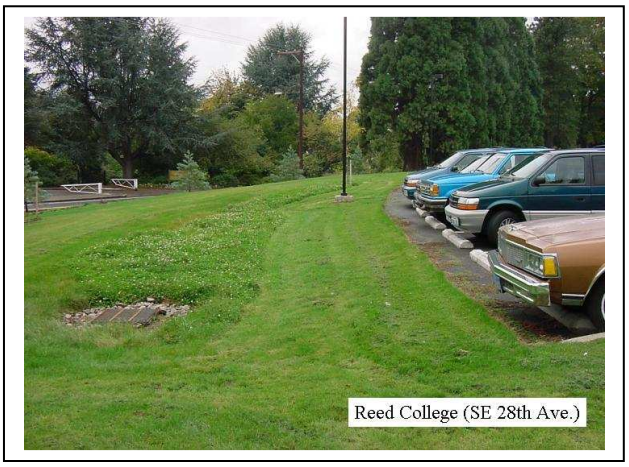
2.9.6 Grassy Swale



Stormwater Management Goals Achieved		Acceptable Sizing Methodologies
√	Pollution Reduction……..	SIM[1], PRES[2]
√	Flow Control…….……	SIM[1]
√		

SIM=Simplified Approach, PRES= Presumptive Approach, PERF= Performance Approach

Notes: 1) Flow and volume control credit will only be given for projects with less than 15,000 square-feet of impervious area to manage. **2)** For projects with more than 15,000 square-feet of impervious area to manage, the presumptive approach must be used to size the swale for pollution reduction, and additional facilities may be required to meet flow control requirements. Grassy swales can be used to manage runoff from parking lots, rooftops, and private streets. For public street runoff, the street swale criteria must be used.



Description: Grassy swales are long narrow grassy depressions used to collect and convey stormwater runoff, allowing pollutants to settle and filter out as the water infiltrates into the ground or flows through the facility. In addition to providing pollution reduction, flow rates and volumes can also be managed for small projects (<15,000 square feet of impervious surface) with grassy swales. Swales should be integrated into the overall site design and can be used to help fulfill a site's required landscaping area requirement. An approved conveyance and disposal method will be required at the end of the swale.

Design Considerations: When designing grassy swales, slopes and depth should be kept as mild as possible to avoid safety risks and prevent erosion within the facility.

Construction Considerations: Grassy swale areas should be clearly marked before site work begins to avoid soil disturbance during construction. No vehicular traffic, except that specifically used to construct the facility, should be allowed within 10 feet of swale areas.

Design Requirements:

Soil Suitability: Grassy swales are appropriate for all soil types. Topsoil shall be used within the top 12 inches of the facility, or the soil shall be amended per Appendix D to support plant growth.

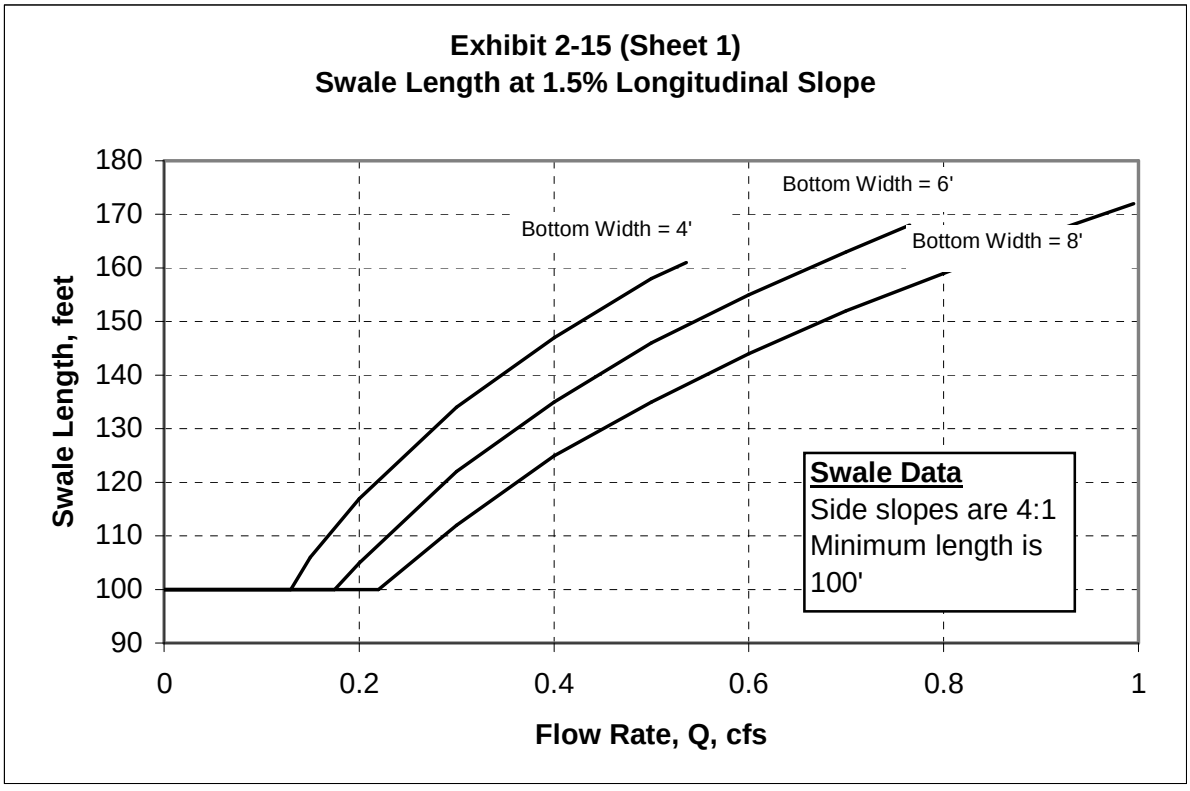
Dimensions and Slopes: Facility storage depth may vary from 6 to 12 inches. Maximum side slopes are 4 horizontal to 1 vertical. Minimum flat bottom width is 2 feet for private swales, and 4 feet for public swales. Maximum longitudinal slope is 5%, while minimum slope is 0.5%. Maximum surrounding ground slopes shall be 10%.

Setbacks: Required setback from centerline of swale to property lines is 5 feet, and 10 feet from building foundations unless lined with impermeable fabric.

Sizing: Grassy swales sized with the simplified approach shall be designed to receive less than 15,000 square-feet of impervious area runoff. For these projects, a simplified approach sizing factor of 0.14 may be used to receive credit for pollution reduction and flow control. A high-flow by-pass mechanism will not be required in these cases, but a high-flow overflow must be provided at the downstream end of the swale to an approved disposal point. In cases when pollution reduction is the only stormwater management goal, or there is more than 15,000 square feet of impervious area to manage, the presumptive approach must be used to size the swale for pollution reduction, and additional facilities will be required to meet flow control requirements, where applicable.

Presumptive Approach Sizing Criteria:

Exhibit 2-15 shows swale side slopes of 4:1 and lengthwise slopes of 1½ percent, 3 percent, and 5 percent. These charts are based on the City standards shown below and may be used to easily determine swale length, given the peak flow rate and the desired swale bottom width.



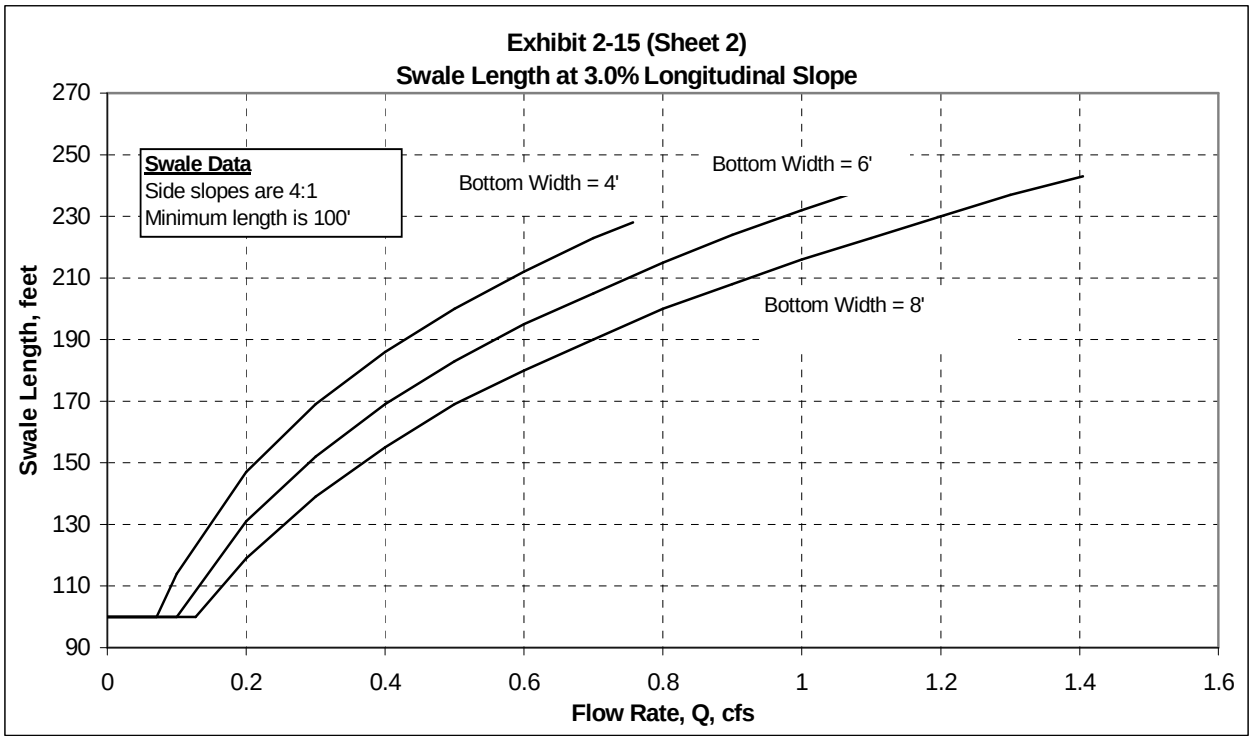


Exhibit 2-15 (Sheet 2)
Swale Length at 3.0% Longitudinal Slope
Swale Data
Side slopes are 4:1
Minimum length is 100'
Bottom Width = 4'
Bottom Width = 6'
Bottom Width = 8'
Swale Length, feet
Flow Rate, Q, cfs
270
250
230
210
190
170
150
130
110
90
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6

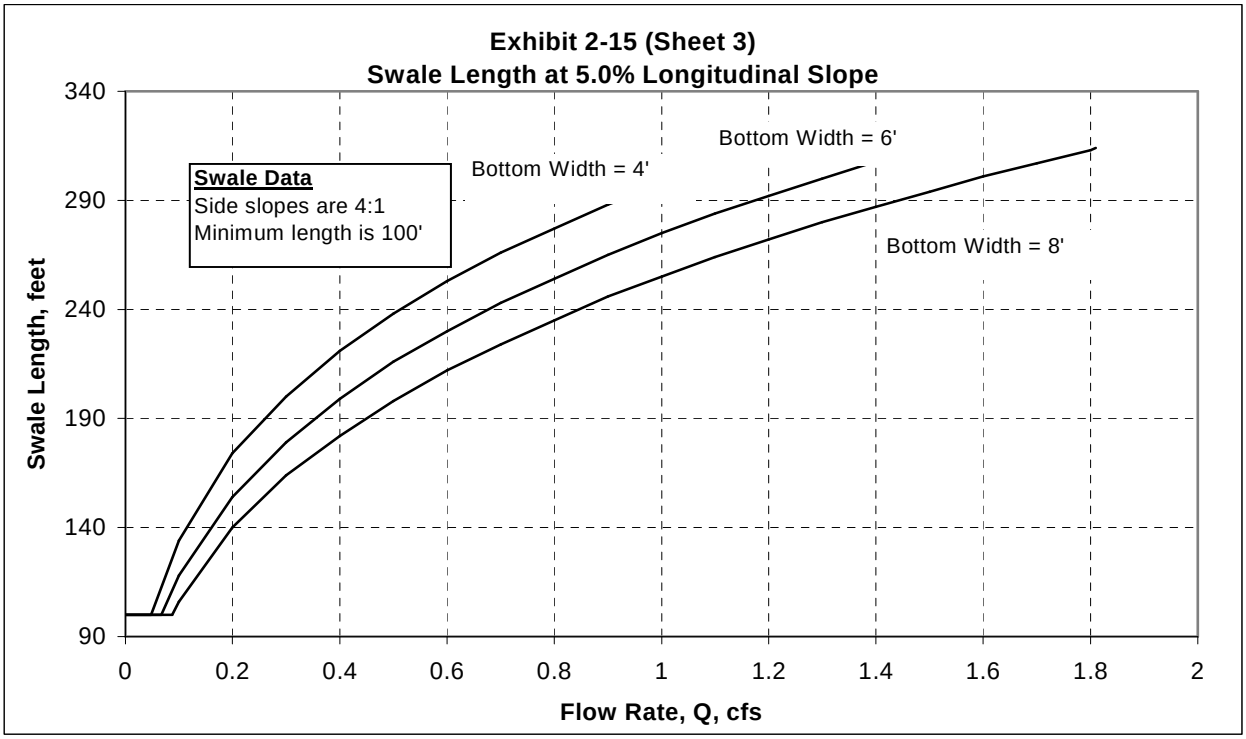


Exhibit 2-15 (Sheet 3)
Swale Length at 5.0% Longitudinal Slope
Swale Data
Side slopes are 4:1
Minimum length is 100'
Bottom Width = 4'
Bottom Width = 6'
Bottom Width = 8'
Swale Length, feet
Flow Rate, Q, cfs
340
290
240
190
140
90
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2

1) The swale width and profile shall be designed to convey runoff from the pollution reduction design storm intensity (see **Section 1.5.2**) at:

- Maximum design depth of 0.33 feet.
- Maximum design velocity of 0.9 feet per second.
- Minimum hydraulic residence time (time for Q_{design} to pass through the swale) of 9 minutes.
- Minimum longitudinal slope of 0.5 percent, maximum slope of 5 percent. For slopes greater than 5 percent, check dams shall be used (one 6-inch high dam every 10 feet).
- Designed using a Manning "n" value of 0.25.
- 4:1 (or flatter) side slopes in the treatment area.
- Minimum length of 100 feet.

A minimum of 1 foot of freeboard above the water surface shall be provided for facilities not protected by high-flow storm diversion devices. Swales without high-flow diversion devices shall be sized to safely convey the 25-year storm event, analyzed using the Rational Method (peak 25-year, 5 minute intensity = 3.32 inches per hour).

Velocity through the facility shall not exceed 3 feet per second (fps) during the high-flow events (i.e., when flows greater than those resulting from the pollution reduction design intensity are not passed around the facility).

2) The swale shall incorporate a flow-spreading device at the inlet. The flow spreader shall provide a uniform flow distribution across the swale bottom. In swales with a bottom width greater than 6 feet, a flow spreader shall be installed at least every 50 feet.

3) To minimize flow channelization, the swale bottom shall be smooth, with uniform longitudinal slope, and with a minimum bottom width of 2 feet for private facilities and 4 feet for public facilities. Maximum bottom width shall be 8 feet.

4) Grasses or sod shall be established as soon as possible after the swale is completed, and before water is allowed to enter the facility.

5) Until vegetation is established, biodegradable erosion control matting appropriate for low-velocity flows (approximately 1 foot per second) shall be installed in the flow area of the swale before allowing water to flow through the swale.

6) Access routes to the swale for maintenance purposes must be shown on the plans. Public swales will need to provide a minimum 8-foot wide access route, not to exceed 10 percent in slope.

Stormwater Report Requirements For Presumptive Approach: See **Exhibit 2-2**.

Landscaping: Plantings shall be designed at the following quantities per **200** square feet of facility area. Facility area is equivalent to the area of the swale calculated from Form SIM. (Note: Facilities smaller than 200 square feet shall have a minimum of one tree per facility.):

1 Evergreen or Deciduous tree:

Evergreen trees: Minimum height: 6 feet.
Deciduous trees: Minimum caliper: 1 ½ inches at 6 inches above base.

Grass: Seed or sod is required to completely cover the grassy swale bottom and side slopes. (Shrubs are optional)

For the swale flow path, approved native grass mixes are preferable and may be substituted for standard swale seed mix. Seed shall be applied at the rates specified by the supplier. The applicant shall have plants established at the time of facility completion (at least 3 months after seeding). No runoff shall be allowed to flow in the swale until grass is established. Trees and shrubs may be allowed in the flow path within swales if the swale exceeds the minimum length and widths specified.

Native wildflowers, grasses, and ground covers used for City maintained facilities shall be designed not to require mowing. Where mowing cannot be avoided, facilities shall be designed to require mowing no more than once annually. Turf and lawn areas are not allowed for City maintained facilities; any exceptions will require City approval.

***Link to Grassy Swale Recommended Seed Mixes**

Checklist of minimal information to be shown on the permit drawings:

(Additional information may be required on the drawings during permit review, depending on individual site conditions.)

1) Facility dimensions and setbacks from property lines and structures
2) Profile view of facility, including typical cross-sections with dimensions
3) Growing medium specification
4) Filter fabric specification (if applicable)
5) All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection
6) Landscaping plan

Inspection requirements and schedule: The following table shall be used to determine which stormwater facility components require City inspection, and when the inspection shall be requested:

Facility Component	Inspection Requirement
Swale grading	Call for inspection
Piping	Call for inspection
Filter fabric (if applicable)	
Growing medium	
Plantings/ seeding/ sod	Call for inspection

Operations and Maintenance requirements: See **Chapter 3.0**.

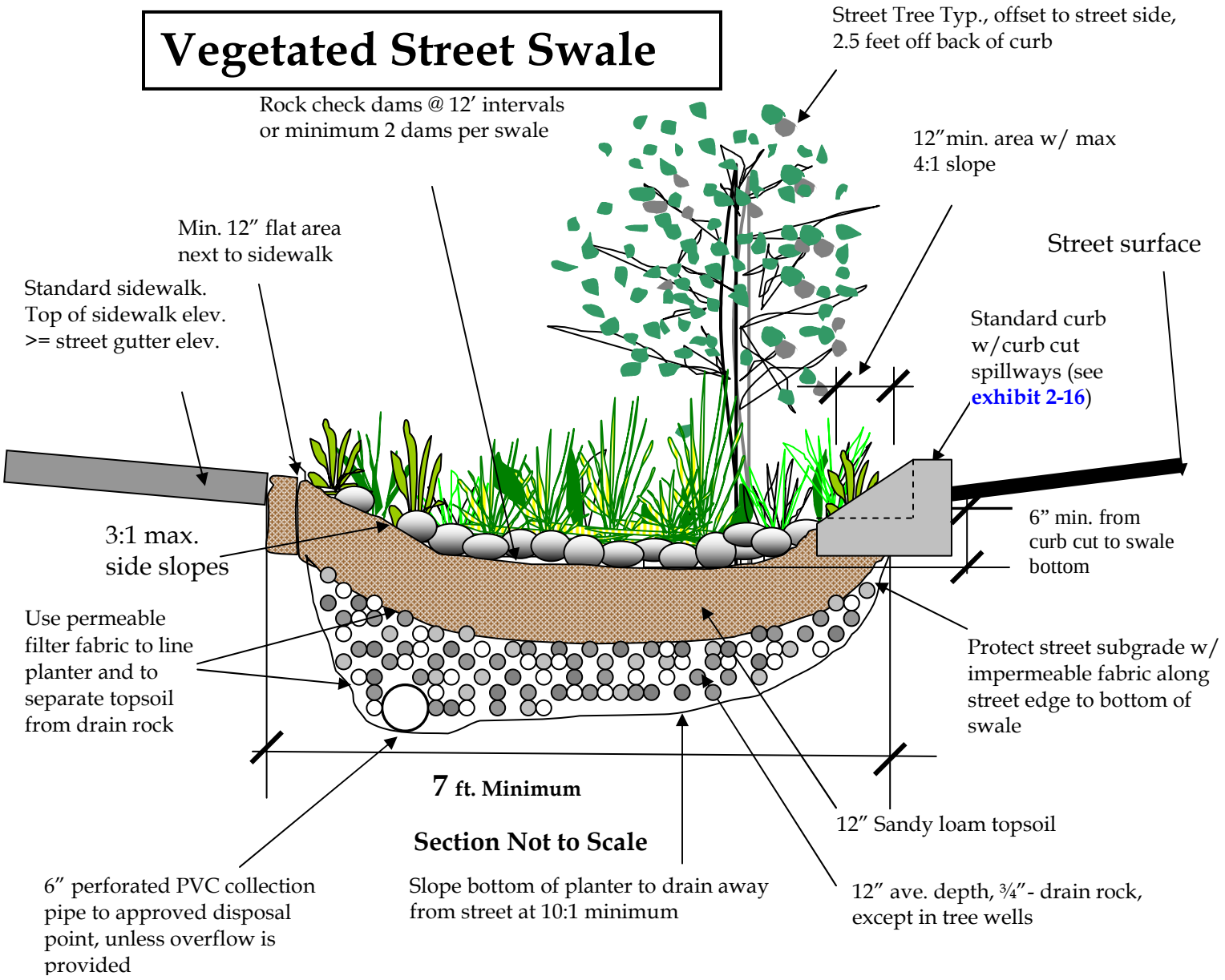
*** Link to grassy swale O&M form**

Additional photos and drawings:

*** Link to grassy swale photos**
*** Link to grassy swale drawings**

2.9.7 Street Swales

Vegetated Street Swale

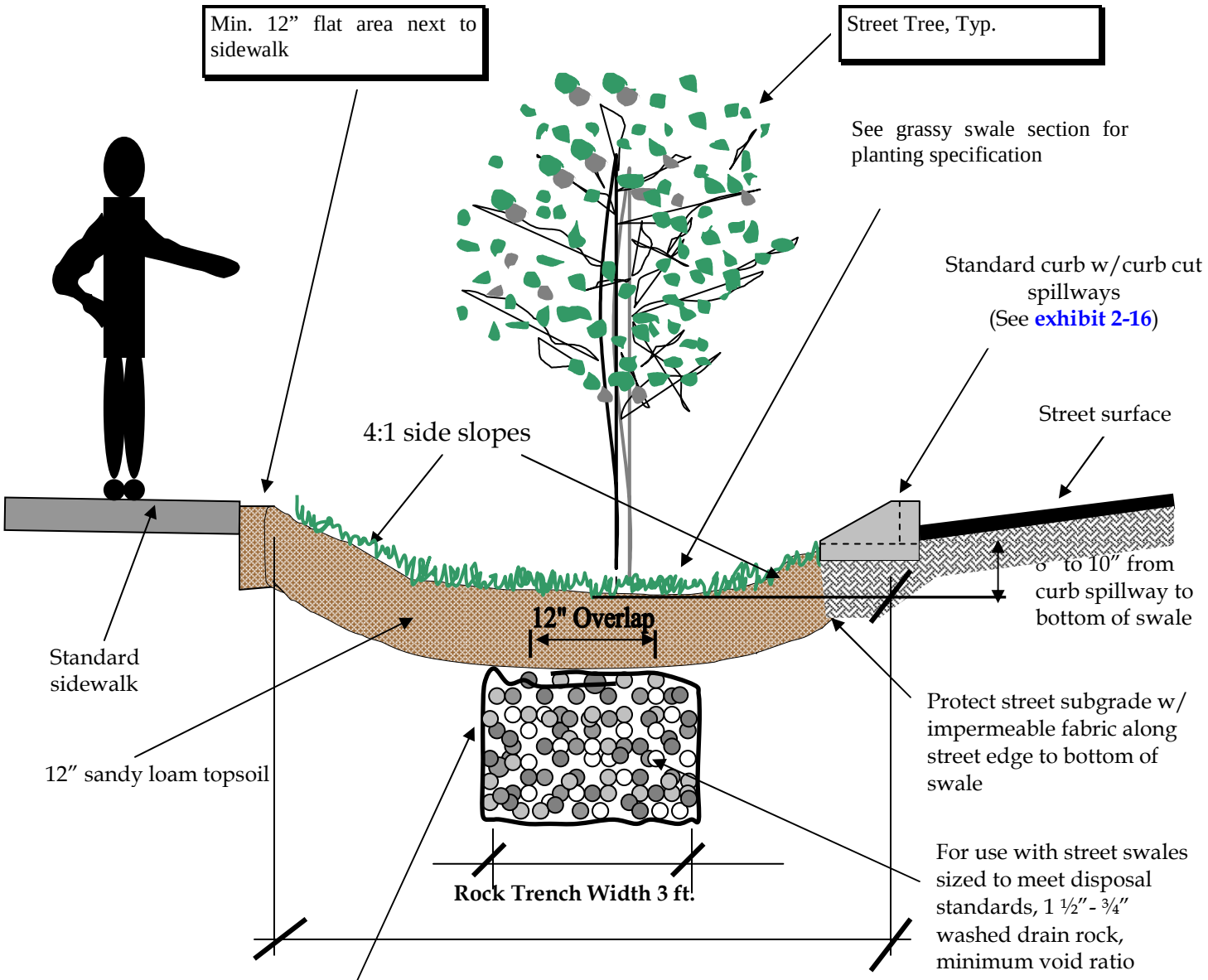


Stormwater Management Goals Achieved	Acceptable Sizing Methodologies
√ Pollution Reduction	SIM
√ Flow Control	SIM

SIM=Simplified Approach, PRES= Presumptive Approach, PERF= Performance Approach

Notes: 1) The surface infiltration facility sizing criteria from **Section 2.2.2** may be used to size the street swale for complete stormwater infiltration. This facility may be used on private property or in the public right-of-way.

Grassy Street Swale



Not to Scale

Note: Overflow to an approved disposal point is required, unless swale is sized in accordance with surface infiltration facility design procedure presented in **Section 2.2.2**.

Description: Street construction poses particular challenges related to stormwater management design. Lack of available space is often the most difficult hurdle in locating stormwater pollution reduction and flow control facilities in or near allocated rights-of-way.

Street swales are long narrow landscaped depressions used to collect and convey stormwater runoff, allowing pollutants to settle and filter out as the water infiltrates into the ground or flows from one bay to the next through the facility. In addition to providing pollution reduction, flow rates and volumes can also be managed with street swales, as check dams are provided every 12 to 20 feet to slow and pool water. Swales should be integrated into the overall site design and can be used to help fulfill a site's required landscaping area requirement. An approved conveyance and disposal method will be required at the end of the swale, unless the swale is designed per the surface infiltration facility criteria presented in **Section 2.2.2**.

Design Considerations: When designing street swales, slopes and depth should be kept as mild as possible to avoid safety risks, improve aesthetics, and prevent erosion within the facility. All applicable ODOT and City requirements for other street elements (curbs, sidewalks, trees, etc.) must be met

If the street planter strip is being used for stormwater treatment and a sidewalk is included, the design may require additional right-of-way to be dedicated to the City so the sidewalk is included in the street right-of-way.

Construction Considerations: Street swale areas should be clearly marked before site work begins to avoid soil disturbance and compaction during construction. No vehicular traffic, except that specifically used to construct the facility, should be allowed within 10 feet of swale areas.

Design Requirements:

Soil Suitability: Street swales are appropriate for all soil types. Topsoil shall be used within the top 12 inches of the facility, or the soil shall be amended per Appendix D to support plant growth.

Dimensions and Slopes: Facility storage depth may vary from 6 to 12 inches. Maximum side slopes are 3 horizontal to 1 vertical for vegetated swales, and 4 horizontal to 1 vertical for grassy swales (to accommodate for mowing). Minimum flat bottom width is 2 feet. Maximum longitudinal slope is 6%.

Setbacks: Required setback from building foundations is 10 feet unless lined with impermeable fabric.

Sizing: To meet pollution reduction and flow control requirements, the square-footage of street swales is to be determined using vegetated or grassy swale sizing criteria (shown on **Form SIM**), depending on which surface treatment is being used. The minimum width for street swales is 7 feet for vegetated, and 9 feet for grassy. Street swales sized with the simplified approach shall be designed to receive less than 15,000 square-feet of impervious area runoff. For these projects, a simplified approach sizing factor of 0.09 may be used to receive credit for pollution reduction and flow control. A high-flow by-pass mechanism will not be required in these cases, but a high-flow overflow must be provided at the downstream end of the swale to an approved disposal point, per **Section 1.4**.

Check Dams: Check dams shall be constructed of durable, non-toxic materials such as rock, brick, or concrete, or soil by integrated them into the grading of the swale. Check dams shall be 12 inches in length, by the width of the swale, by 3 to 5 inches in height.

Landscaping: Vegetation helps improve infiltration functions, protects from rain and wind erosion, and enhances aesthetic conditions. The "facility area" is equivalent to the area of the swale, including bottom and side slopes, as calculated from Form SIM. Turf grass may be used to cover the entire swale surface area. If plantings are chosen to landscape the swale, the minimum plant material quantities per 100 square feet of facility area shall be as follows:

4 - Large shrubs/small trees: 3-gallon containers or equivalent.
6 - Shrubs/large grass-like plants: 1-gallon containers or equivalent

Ground cover plants: 1 per 12 inches on center, triangular spacing, for the ground cover planting area only, unless seed or sod is specified. Minimum container: 4-inch pot. At least 50 percent of the facility shall be planted with grasses or grass-like plants.

Wildflowers, native grasses, and ground covers used for City-maintained facilities shall be designed not to require mowing. Where mowing cannot be avoided, facilities shall be designed to require mowing no more than once annually.

Recommended street trees in or near street swales:

With overhead power lines	**Without overhead power lines**
Carpinus caroliniana	Acer campestre 'Evelyn'
Cercis Canadensis	Betula jacquemontii
Fraxinus pennsylvanica 'Johnson'	Celtis occidentalis
Gleditsia triacanthos 'Impcole'	Gleditsia triacanthos 'Skycole'
Koelreuteria paniculata	Nyssa sylvatica
Prunus virginiana 'Canada Red'	Quercus shumardii

Checklist of minimal information to be shown on the permit drawings:

(Additional information may be required on the drawings during permit review, depending on individual site conditions.)

1) Facility dimensions and setbacks from property lines and structures
2) Profile view of facility, including typical cross-sections with dimensions
3) Growing medium specification
4) Filter fabric specification (if applicable)
5) All curb cut details and stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection
6) Landscaping plan

Inspection requirements and schedule: The following table shall be used to determine which stormwater facility components require City inspection, and when the inspection shall be requested:

Facility Component	Inspection Requirement
Swale grading	Call for inspection
Curbs / curb cuts	Call for inspection
Piping (if applicable)	Call for inspection
Filter fabric (if applicable)	
Growing medium	
Plantings	Call for inspection

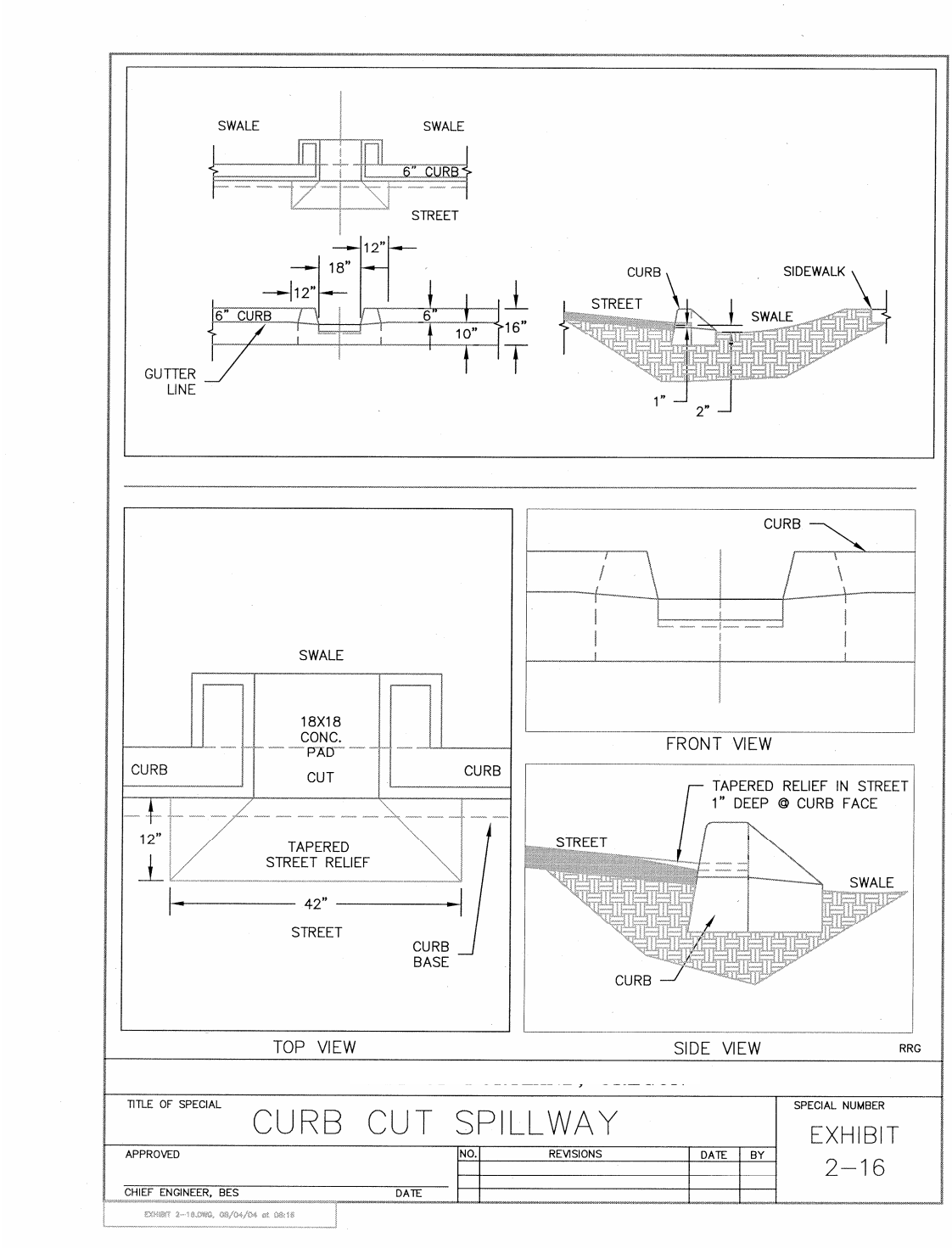
Operations and Maintenance requirements: See **Chapter 3.0**.

*** Link to vegetated and grassy swale O&M form**

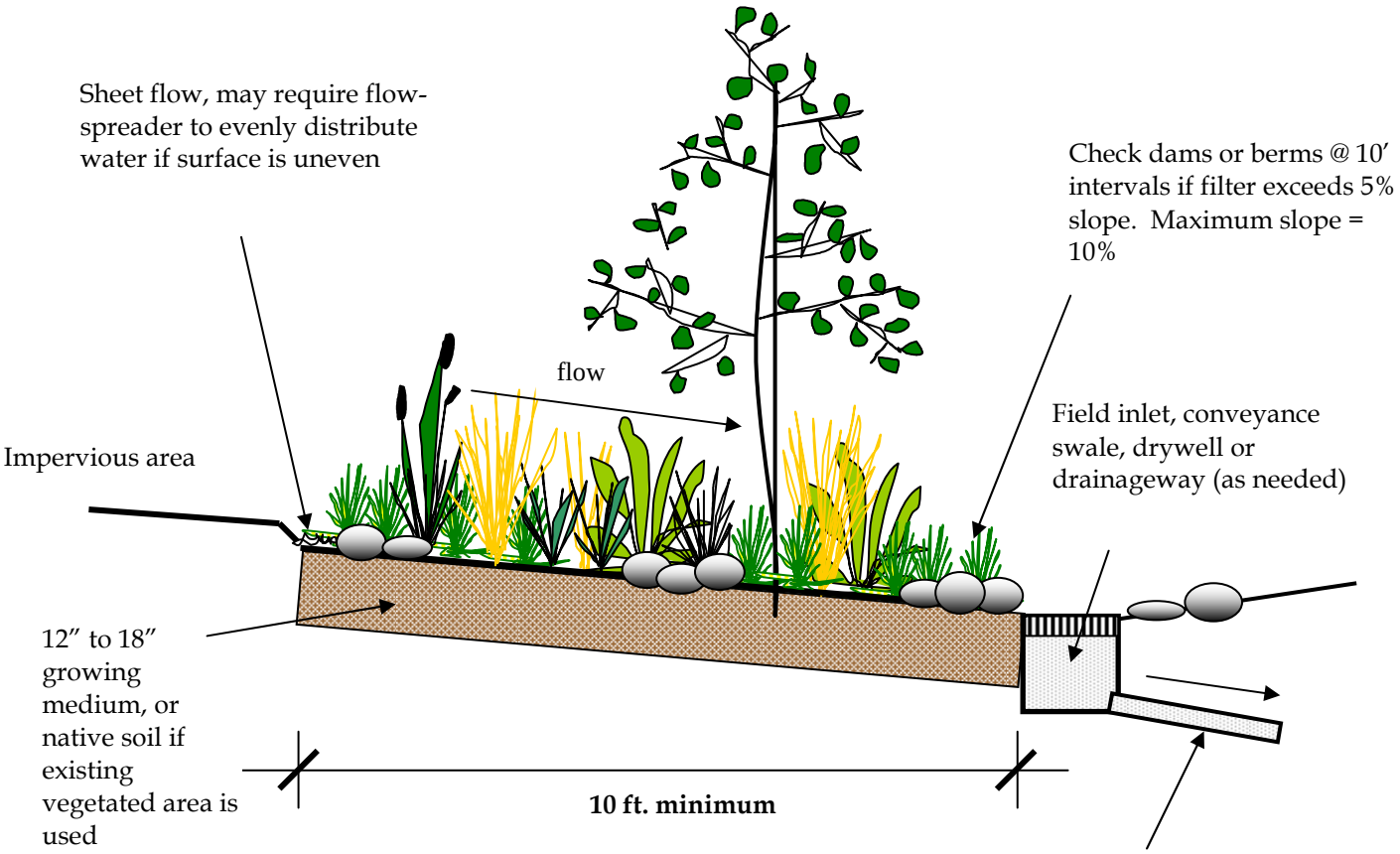
Additional photos and drawings:

*** Link to street swale photos**

*** Link to street swale drawings**



2.9.8 Vegetated Filter

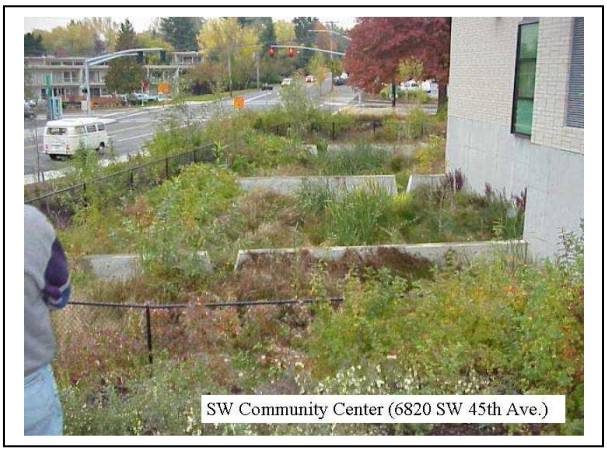


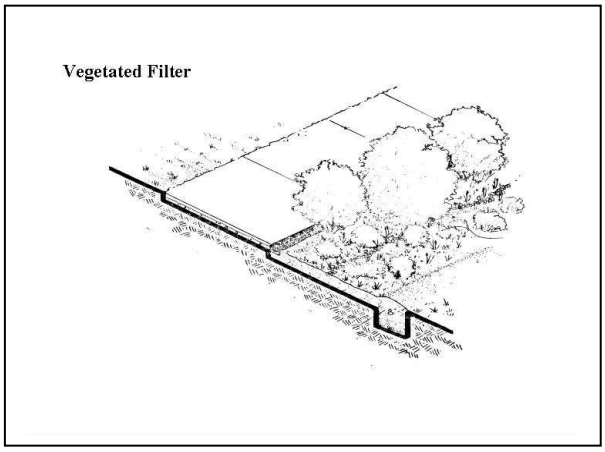
Section Not to Scale

Stormwater Management Goals Achieved	Acceptable Sizing Methodologies
√ Pollution Reduction……..	SIM, PERF[1]
√ Flow Control……..	SIM

SIM=Simplified Approach, PRES= Presumptive Approach, PERF= Performance Approach

Notes: 1) The Performance Approach may be used to downsize the simplified approach sizing factor when the only goal is pollution reduction. Vegetated filters can be used to manage stormwater from rooftops, pathways, parking lots, and potentially streets (with flow spreaders or if the runoff is left as unconcentrated sheet flow).





Description: Vegetated filter strips, or vegetated filters, are gently sloping areas used to filter, slow, and infiltrate stormwater flows. Stormwater enters the filter as sheet flow from an impervious surface or is converted to sheet flow using a flow spreader. Flow control is achieved using the relatively large surface area and for slopes greater than 5%, a generous proportion of check dams or berms. Pollutants are removed through filtration and sedimentation. Filters can be planted with a variety of trees, shrubs, and ground covers, including grasses. Sod may be used for single-family residential sites, where a simple downspout disconnection into lawn or landscaping is used. There can be many ways to fit this concept into site designs and designers are encouraged to use the site landscape areas for this purpose. Unless the filter is designed for stormwater disposal, an approved conveyance and disposal method will be required at the end of the filter.

Design Considerations: When designing vegetated filters, slopes should be kept as flat as possible to prevent erosion. Spreading the flow evenly across the filter is also important in ensuring that the facility functions correctly and avoids flow channeling.

Construction Considerations: Vegetated filter areas should be clearly marked before site work begins to avoid soil disturbance during construction. No vehicular traffic, except that specifically used to construct the facility, should be allowed within 10 feet of filter areas. Flow spreaders must be constructed perfectly level to distribute flows evenly across the filter, and for public facilities must be surveyed after construction.

Design Requirements:

Soil Suitability: Vegetated filters are appropriate for all soil types. Unless existing vegetated areas are used for the filter, topsoil shall be used within the top 12 inches of the facility, or the soil shall be amended per Appendix D to support plant growth.

Dimensions and Slopes: Maximum allowable vegetated filter slopes are 10%. Terraces may be used to decrease ground slopes. Minimum slopes are 0.5%.

Setbacks: Required setback from property lines is 5 feet, and 10 feet from building foundations unless lined with impermeable fabric.

Sizing: Unless used for very long, narrow projects such as pathways and trails, vegetated filters cannot be used to manage flow from more than 2,000 square-feet of impervious area. Filters shall be a minimum of 10 feet wide x 10 feet long. A simplified approach sizing factor of 0.24 may be used to receive credit for pollution reduction and flow control. A high-flow by-pass mechanism will not be required in these cases, but a high-flow overflow must be provided at the downstream end of the filter to an approved disposal point. In cases when pollution reduction is the only stormwater management goal, the performance approach may be used in conjunction with a measured infiltration rate to downsize the simplified approach sizing factor.

Check Dams: Check dams shall be constructed of durable, non-toxic materials such as rock, brick, or concrete, or graded into the native soils. Check dams shall be 12 inches in length, by the width of the filter, by 3 to 5 inches in height.

Landscaping: Vegetation helps improve infiltration functions, protects from rain and wind erosion, and enhances aesthetic conditions. Sod may be used for single-family residential sites, where a simple downspout disconnection into lawn or landscaping is used. For other projects, minimum plant material quantities per **100** square feet of facility area are as follows. The "facility area" is equivalent to the area of the filter, as calculated from Form SIM.

1 - Evergreen or deciduous tree (planted around the perimeter of the swale):

Evergreen trees:	Minimum height: 6 feet
Deciduous trees:	Minimum caliper: 1 ½ inches at 6 inches above base.
4 - Large shrubs/small trees:	3-gallon containers or equivalent.
6 - Shrubs/large grass-like plants:	1-gallon containers or equivalent

Ground cover plants: 1 per 12 inches on center, triangular spacing, for the ground cover planting area only, unless seed or sod is specified. Minimum container: 4-inch pot. At least 50 percent of the facility shall be planted with grasses or grass-like plants.

Wildflowers, native grasses, and ground covers used for City maintained facilities shall be designed not to require mowing. Where mowing cannot be avoided, facilities shall be designed to require mowing no more than once annually. Turf and lawn areas are not allowed for City maintained facilities; any exceptions will require City approval.

Checklist of minimal information to be shown on the permit drawings:

(Additional information may be required on the drawings during permit review, depending on individual site conditions.)

1) Facility dimensions and setbacks from property lines and structures
2) Profile view of facility, including typical cross-sections with dimensions
3) Growing medium specification (if applicable)
4) All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection
5) Landscaping plan
6) Flow spreader details and specifications
7) Check dam or terrace details and specifications

Inspection requirements and schedule: The following table shall be used to determine which stormwater facility components require City inspection, and when the inspection shall be requested:

Facility Component	Inspection Requirement
Filter grading (if applicable)	Call for inspection
Flow spreaders/Terraces (if applicable)	Call for inspection
Piping (if applicable)	Call for inspection
Growing medium (if applicable)	
Plantings	Call for inspection

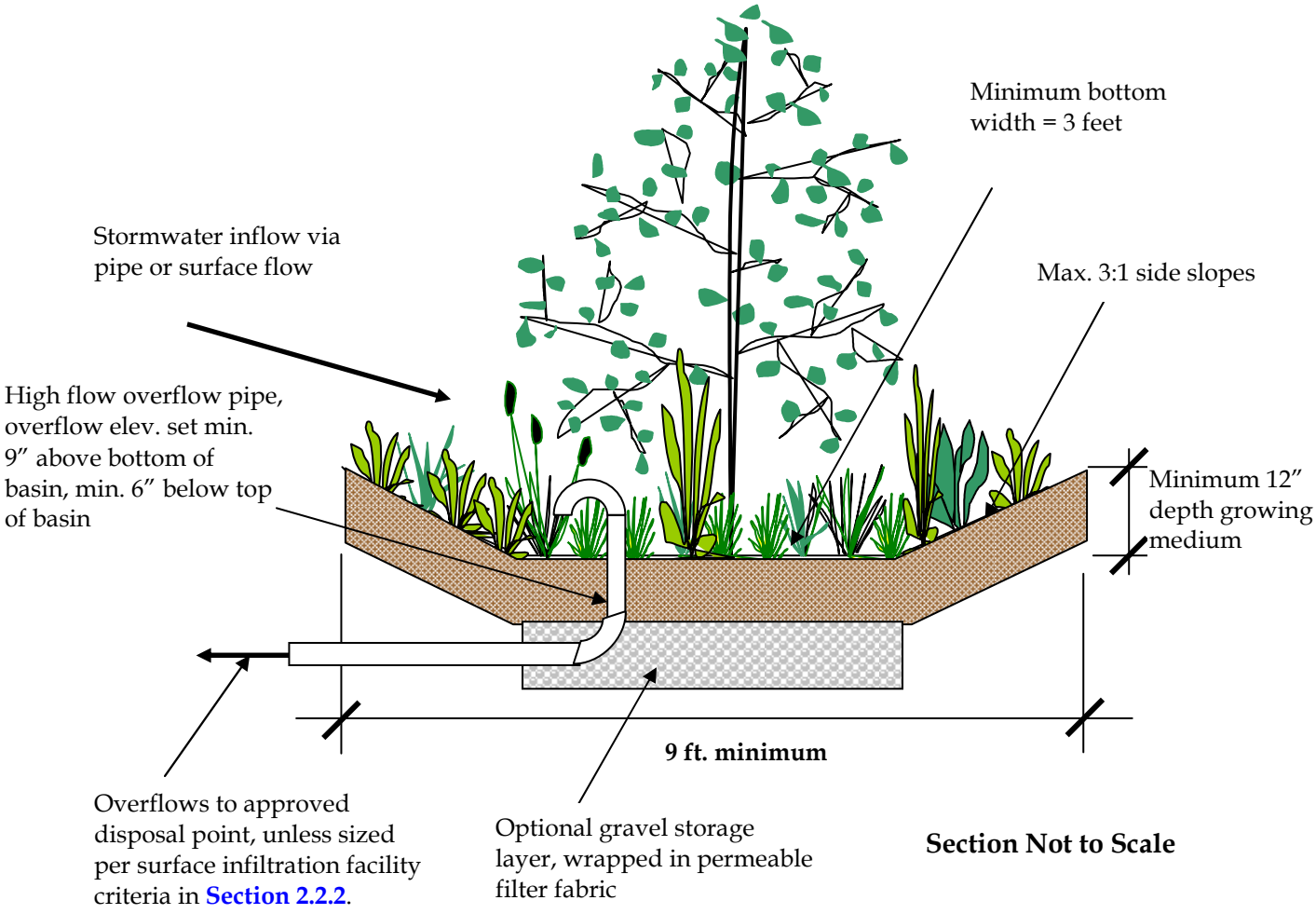
Operations and Maintenance requirements: See **Chapter 3.0**.

*** Link to vegetated filter O&M form**

Additional photos and drawings:

*** Link to vegetated filter photos**
*** Link to vegetated filter drawings**

2.9.9 Vegetated Infiltration Basin



Stormwater Management Goals Achieved		Acceptable Sizing Methodologies
√	Pollution Reduction……..	SIM, PERF[1]
√	Flow Control…….……	SIM

SIM=Simplified Approach, PRES= Presumptive Approach, PERF= Performance Approach

Notes: 1) The performance approach may be used to downsize the simplified approach sizing factor when the only goal is pollution control.

Description: Vegetated infiltration basins are shallow landscaped depressions used to collect and hold stormwater runoff, allowing pollutants to settle and filter out as the water infiltrates into the ground. In addition to providing pollution reduction, flow rates and volumes can also be managed with vegetated infiltration basins. They should be integrated into the overall site design and can be used to help fulfill a site's required landscaping area requirement. As shown in the example photos, the design can be formal or informal in character and planting scheme. An overflow mechanism to an approved conveyance and disposal method will be required, unless the basin is designed per surface infiltration facility guidelines presented in **Section 2.2.2**.

Design Considerations: When designing vegetated infiltration basins, the infiltration rate of the native soil is a key element in determining size and viability. Slopes and depth should be minimized to avoid safety risks.

Construction Considerations: Infiltration basin areas should be clearly marked before site work begins to avoid soil disturbance during construction. No vehicular traffic, except that specifically used to construct the facility, should be allowed within 10 feet of infiltration basin areas.

Design Requirements:

Soil Suitability: Vegetated infiltration basins are appropriate for soils with a minimum infiltration rate of 2 inches per hour (NRCS soil types A and B). There shall be no less than three feet of undisturbed infiltration medium between the bottom of the facility and any impervious layer (i.e. hardpan, solid rock, high groundwater levels, etc.). Topsoil shall be used within the top 12 inches of the facility, or the soil shall be amended per Appendix D to support plant growth.

Dimensions: Facility storage depth may vary from 9 to 18 inches. Maximum side slopes are 3 horizontal to 1 vertical. Minimum bottom width is 2 feet.

Setbacks: Required setback from property lines is 5 feet, and 10 feet from building foundations. Infiltration basins shall meet the following setback requirements from downstream slopes: minimum of 100 feet from slopes of 10%; add 5 feet of setback for each additional percent of slope up to 30%; infiltration trenches shall not be used where slopes exceed 30%.

Sizing: Vegetated infiltration basins sized with the simplified approach shall be designed to receive less than 15,000 square-feet of impervious area runoff. For these projects, a simplified approach sizing factor of 0.11 may be used to receive credit for pollution reduction and flow control. A high-flow overflow must be provided, or to receive credit for complete stormwater infiltration, the surface infiltration facility design criteria from **Section 2.2.2** must be used. In this case, pre and post-construction infiltration tests are required to demonstrate infiltration performance. In cases when pollution reduction is the only stormwater management goal, the performance approach may be used in conjunction with a measured infiltration rate to downsize the simplified approach sizing factor. Drawdown time (time for the basin to empty when full) shall not exceed 30 hours.

Landscaping: Vegetation helps improve infiltration functions, protects from rain and wind erosion, and enhances aesthetic conditions. The "facility area" is equivalent to the area of the basin, including bottom and side slopes, plus a 10-foot buffer around the basin. Minimum plant material quantities per 300 square feet of facility area are as follows:

1 - Evergreen or deciduous tree (planted around the perimeter of the basin):		
	Evergreen trees:	Minimum height: 6 feet
	Deciduous trees:	Minimum caliper: 1 ½ inches at 6 inches above base.
4 - Large shrubs/small trees:		3-gallon containers or equivalent.
6 - Shrubs/large grass-like plants:		1-gallon containers or equivalent

Ground cover plants: 1 per 12 inches on center, triangular spacing, for the ground cover planting area only, unless seed or sod is specified. Minimum container: 4-inch pot. At least 50 percent of the facility shall be planted with grasses or grass-like plants.

Wildflowers, native grasses, and ground covers used for City maintained facilities shall be designed to not require mowing. Where mowing cannot be avoided, facilities shall be designed to require mowing no more than once annually. Turf and lawn areas are not allowed for City maintained facilities; any exceptions will require City approval.

For public vegetated infiltration basins, the following additional design criteria shall apply:

1) Two staff gauges shall be installed at opposite ends of the bottom of the basin, to enable maintenance staff to measure the depth of accumulated silts.
2) A soil scientist, or suitably trained person working under the supervision of an Oregon licensed professional geotechnical engineer, shall inspect the soil after the system is excavated to confirm that soils remain in suitable condition for infiltration.

Checklist of minimal information to be shown on the permit drawings:

(Additional information may be required on the drawings during permit review, depending on individual site conditions.)

1) Facility dimensions and setbacks from property lines and structures
2) Profile view of facility, including typical cross-sections with dimensions
3) Growing medium specification
4) Filter fabric specification (if applicable)
5) All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection
6) Landscaping plan

Inspection requirements and schedule: The following table shall be used to determine which stormwater facility components require City inspection, and when the inspection shall be requested:

Facility Component	Inspection Requirement
Basin grading	Call for inspection
Piping	Call for inspection
Filter fabric	
Growing medium	
Plantings	Call for inspection

Operations and Maintenance requirements: See **Chapter 3.0**.

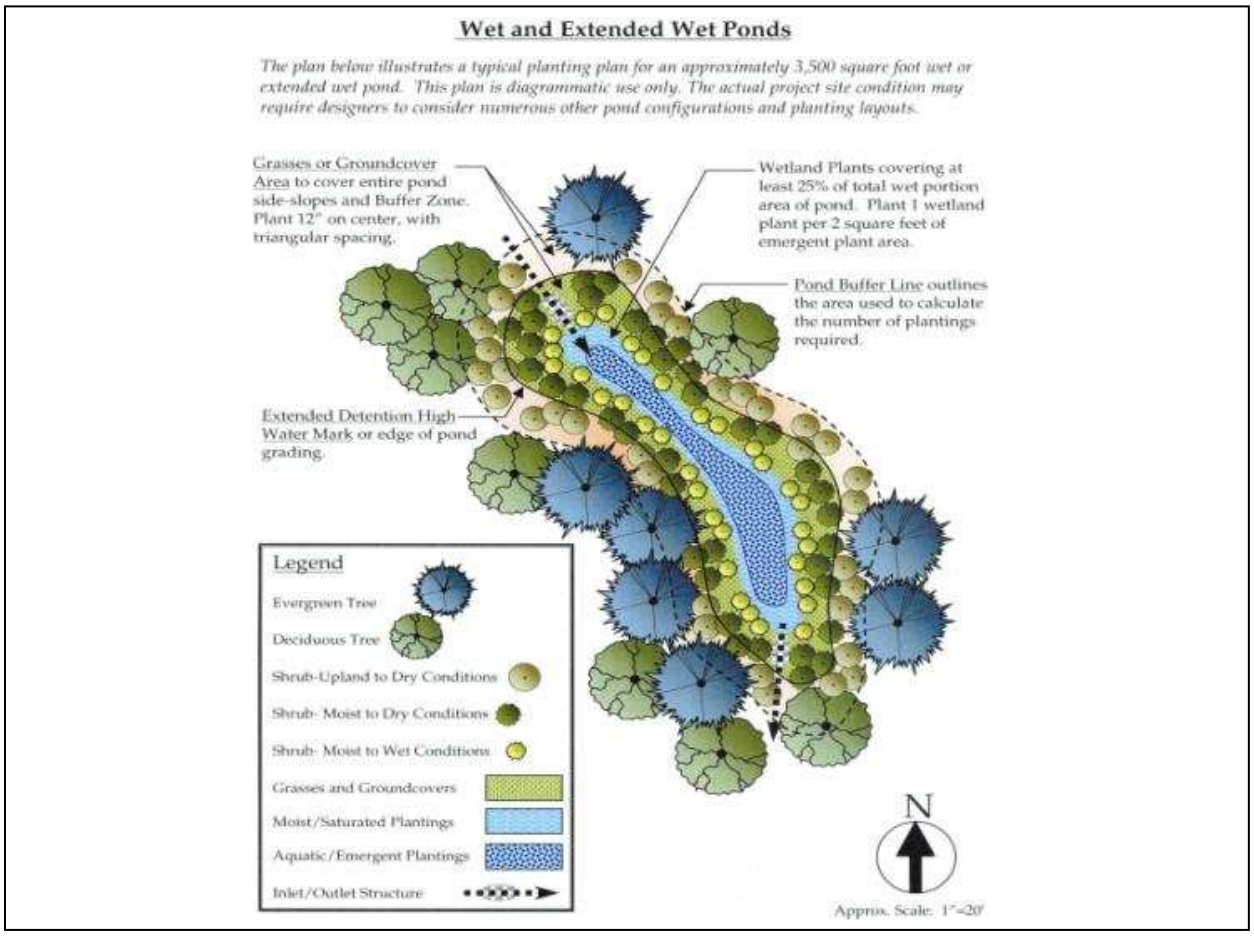
*** Link to vegetated infiltration basin O&M form**

Additional photos and drawings:

*** Link to vegetated infiltration basin photos**

*** Link to vegetated infiltration basin drawings**

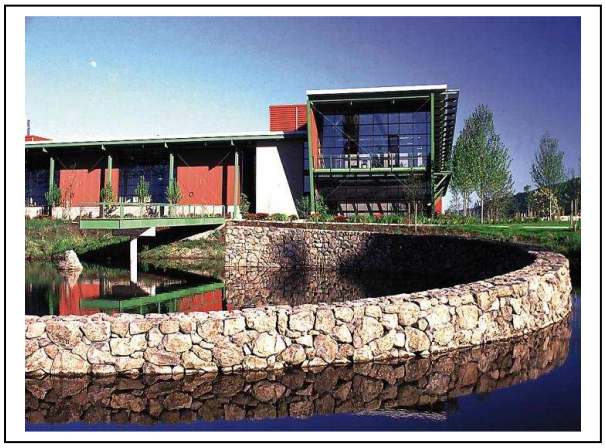
2.9.10 Wet, Extended Wet, & Dry Detention Ponds



Stormwater Management Goals Achieved		Acceptable Sizing Methodologies
√	Pollution Reduction……..	PRES[1]
√	Flow Control……..……	PRES[2]

SIM=Simplified Approach, PRES= Presumptive Approach, PERF= Performance Approach

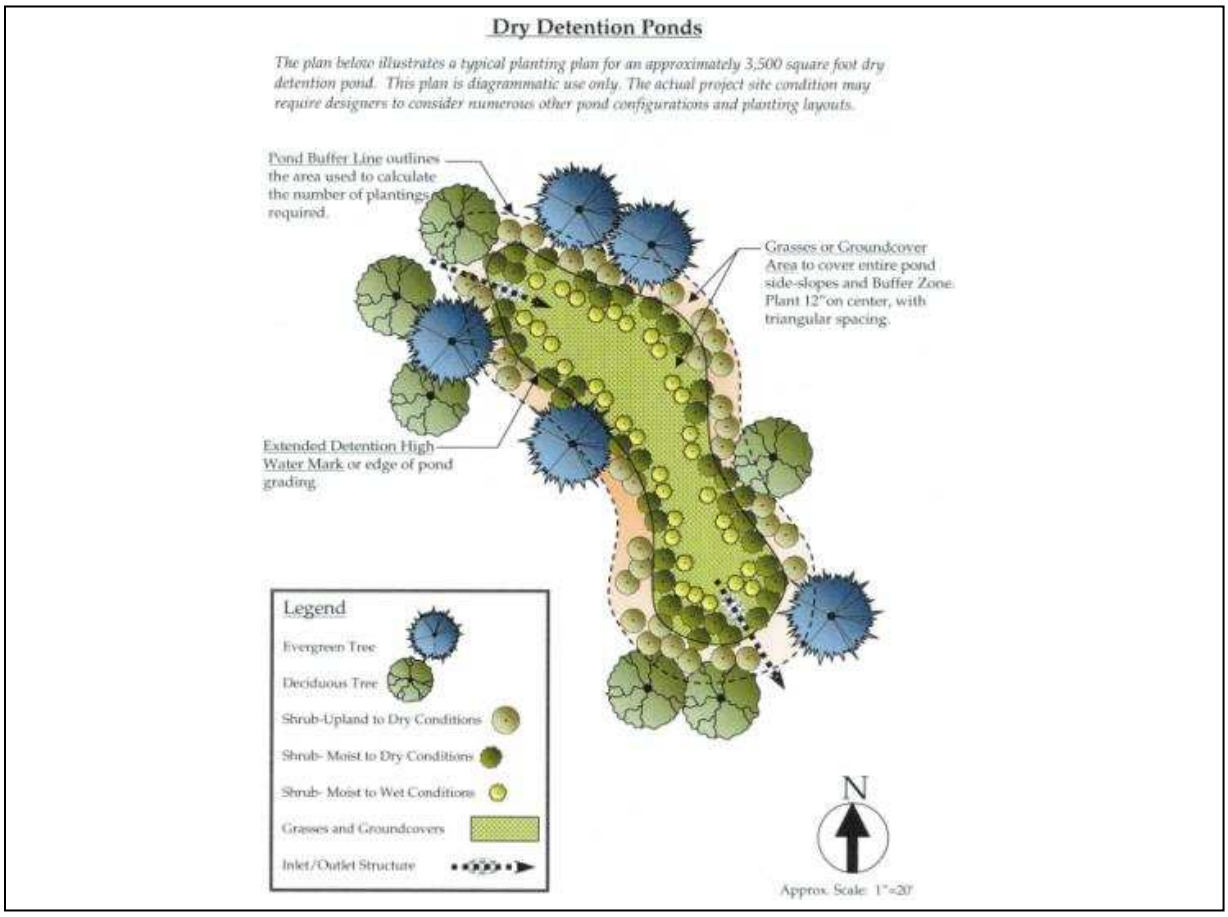
Notes: 1) Wet and extended wet detention ponds receive credit for pollution reduction. For dry detention ponds to receive credit for pollution reduction, the bottom flow path of the pond must be designed as a vegetated or grassy swale, with sizing and design in accordance with criteria presented in this chapter. **2)** Only extended wet detention and dry detention ponds receive credit for flow control. All ponds must overflow to an acceptable stormwater disposal. Wet and extended wet detention ponds can be used to provide pollution reduction for any impervious surfaces, and must be located outside of public rights-of-way.



Wet Pond Description: Wet ponds are constructed with a permanent pool of water (called pool storage or dead storage). Stormwater runoff enters the pond at one end and displaces water from the permanent pool. Pollutants are removed from stormwater through gravitational settling and biologic processes. When the sizing criteria presented in this section is used, pollution reduction requirements are presumed to be met. Additional facilities will be required to meet flow control requirements, as applicable. An overflow mechanism to an approved conveyance and disposal method will be required.

Extended Wet Detention Pond Description: Extended wet detention ponds are constructed with a permanent pool of water (called pool storage or dead storage) and additional storage above, which fills during storm events and releases water slowly over a number of hours. The permanent pool is sized to provide pollution reduction, and the additional storage above (extended detention area) is sized to meet flow control requirements. Pollutants are removed from stormwater through gravitational settling and biologic processes. When the sizing criteria presented in this section is used, pollution reduction requirements are presumed to be met. The extended detention portion of this facility must be designed using acceptable hydrologic modeling techniques (see **Section 2.3**) to meet applicable flow control requirements (see **Section 1.6.2**). An overflow mechanism to an approved conveyance and disposal method will be required.

Dry Detention Pond Description: Dry detention ponds are vegetated basins designed to fill during storm events and slowly release the water over a number of hours. Dry detention ponds must be designed using acceptable hydrologic modeling techniques (see **Section 2.3**) to meet applicable flow control requirements (see **Section 1.6.2**). Additional facilities are required to meet pollution reduction requirements, unless the bottom flow path of the pond is designed as a vegetated or grassy swale, per swale sizing and design criteria. An overflow mechanism to an approved conveyance and disposal method will be required.


Dry Detention Ponds
The plan below illustrates a typical planting plan for an approximately 3,500 square foot dry detention pond. This plan is diagrammatic use only. The actual project site condition may require designers to consider numerous other pond configurations and planting layouts.
Pond Buffer Line outlines the area used to calculate the number of plantings required.
Grasses or Groundcover Area to cover entire pond side-slopes and Buffer Zone. Plant 12"on center, with triangular spacing.
Extended Detention High Water Mark or edge of pond grading.
Legend
Evergreen Tree
Deciduous Tree
Shrub-Upland to Dry Conditions
Shrub- Moist to Dry Conditions
Shrub- Moist to Wet Conditions
Grasses and Groundcovers
Inlet/Outlet Structure
N
Approx. Scale: 1"=20'

Design Considerations: Slopes and depth should be kept as mild as possible to avoid safety risks. Wet and extended wet detention ponds should be designed for large drainage areas (5 to 150 acres) to help avoid problems associated with long periods of stagnant water. The City encourages applicants to design ponds to function as multi-purpose facilities (e.g., parks, open space, recreation facilities, or parking lots), provided that any alternative uses are compatible with the primary stormwater functions and maintenance standards. Instream ponds are not encouraged. If used, they require special approvals from the National Marine Fisheries Service, Oregon Department of Fish and Wildlife, Oregon Division of State Lands, and City of Grants Pass, in addition to water rights from the Oregon Division of Water Rights.

Construction Considerations: As pond grading generally requires the topsoil to be removed to form the basin shape of the pond, the resulting top layers of soil must to be amended, or topsoil must be brought back in to ready the soil for planting.

Location and Ownership:

- All open ponds to be maintained by the City of Grants Pass shall be located in a separate open space tract with public sewer easements dedicated to the City.
- Open ponds serving more than one tax lot, or designed to function as multi-use/recreational facilities, shall be located in a separate tract (e.g., Tract A), defined easement, or designated open space.

Setbacks: Ponds shall be constructed to maintain the following setback distances from structures and other facilities. (All distances are measured from the edge of the maximum water surface elevation. The setback limit applies to ponds near the top of slope, not the bottom.)

- Minimum distance from the edge of the pond water surface to property lines and structures: 20 feet, unless an easement with adjacent property owner is provided.
- Distance from the toe of the pond berm embankment to the nearest property line: one-half of the berm height (minimum distance of 5 feet).
- Minimum distance from the edge of the pond water surface to septic tank, distribution box, or septic tank drain field: 50 feet.
- Surrounding slopes shall not exceed 10%. Minimum distance from the edge of the pond water surface to the top of a slope greater than 15 percent: 200 feet, unless a geotechnical report is submitted and approved by the City Engineer (**Exhibit 2-18**).
- Minimum distance from the edge of the pond water surface to a well: 100 feet (**Exhibit 2-18**).

Geometry/Design Requirements:

- Slopes within the pond shall not exceed 3 horizontal to 1 vertical.
- The distance between all inlets and the outlet shall be maximized to facilitate sedimentation. The minimum length-to-width ratio is 3:1, at the maximum water

surface elevation. This ratio is critical to prevent "short-circuiting," where water passes directly through the facility without being detained for any length of time. If area constraints make this ratio unworkable, baffles, islands, or peninsulas may be installed, with City approval, to increase the flow path and prevent short-circuiting.

- The maximum depth of the pond shall not exceed 4 feet. The 0 to 2-foot depth shall be distributed evenly around the perimeter of the pond.
- Minimum freeboard shall be 1 foot above the highest potential water surface elevation (one foot above the emergency overflow structure or spillway elevation).
- Wet and extended wet detention ponds are applicable in NRCS Type C and D soils (A and B soils with impermeable liner). Topsoil shall be used within the top 12 inches of the facility, or the soil shall be amended per Appendix F to support plant growth.
- Dry detention ponds are applicable in NRCS type B, C, and D soils (the pond should most likely be designed as an infiltration basin in type A soils). Topsoil shall be used within the top 12 inches of the facility, or the soil shall be amended per Appendix D to support plant growth.
- Unless designed with a pollution reduction swale in the bottom flow path, dry detention ponds shall be divided into a minimum of two cells. The first cell (forebay) shall contain approximately 10 percent of the design surface area, and shall provide at least 0.5 feet of dead storage for sediment accumulation.
- Wet and extended wet detention ponds shall be divided into a minimum of two cells. The first cell (forebay) shall contain approximately 10 percent of the design surface area, and shall provide at least 0.5 feet of dead storage for sediment accumulation.

- Public ponds shall be designed with an upstream sedimentation manhole with downturned elbow or tee riser outflow pipe (See Exhibit 2-32) to trap oils and reduce the likelihood of a visible sheen on the pond surface.
- Access routes to the pond for maintenance purposes must be shown on the plans. Public ponds will need to provide a minimum 8-foot wide access route, not to exceed 10 percent in slope.
- Where possible, a dewatering outlet with shut-off valve shall be provided to aid in the maintenance of the permanent pool.
- For wet and extended wet detention ponds, a water budget shall be submitted for review. The water budget must demonstrate that the baseflow to the pond is sufficient such that water stagnation/alga matting will not become a problem.

Outlet/ Overflow:

- If a riser pipe outlet is used, it shall be protected by a trash rack and anti-vortex plate. If an orifice plate is used, it shall be protected with a trash rack with at least 10 square feet of open surface area. In both cases, the rack must be hinged or easily removable to allow for cleaning. The rack shall be adequately secured to prevent it from being removed or opened when maintenance is not occurring.

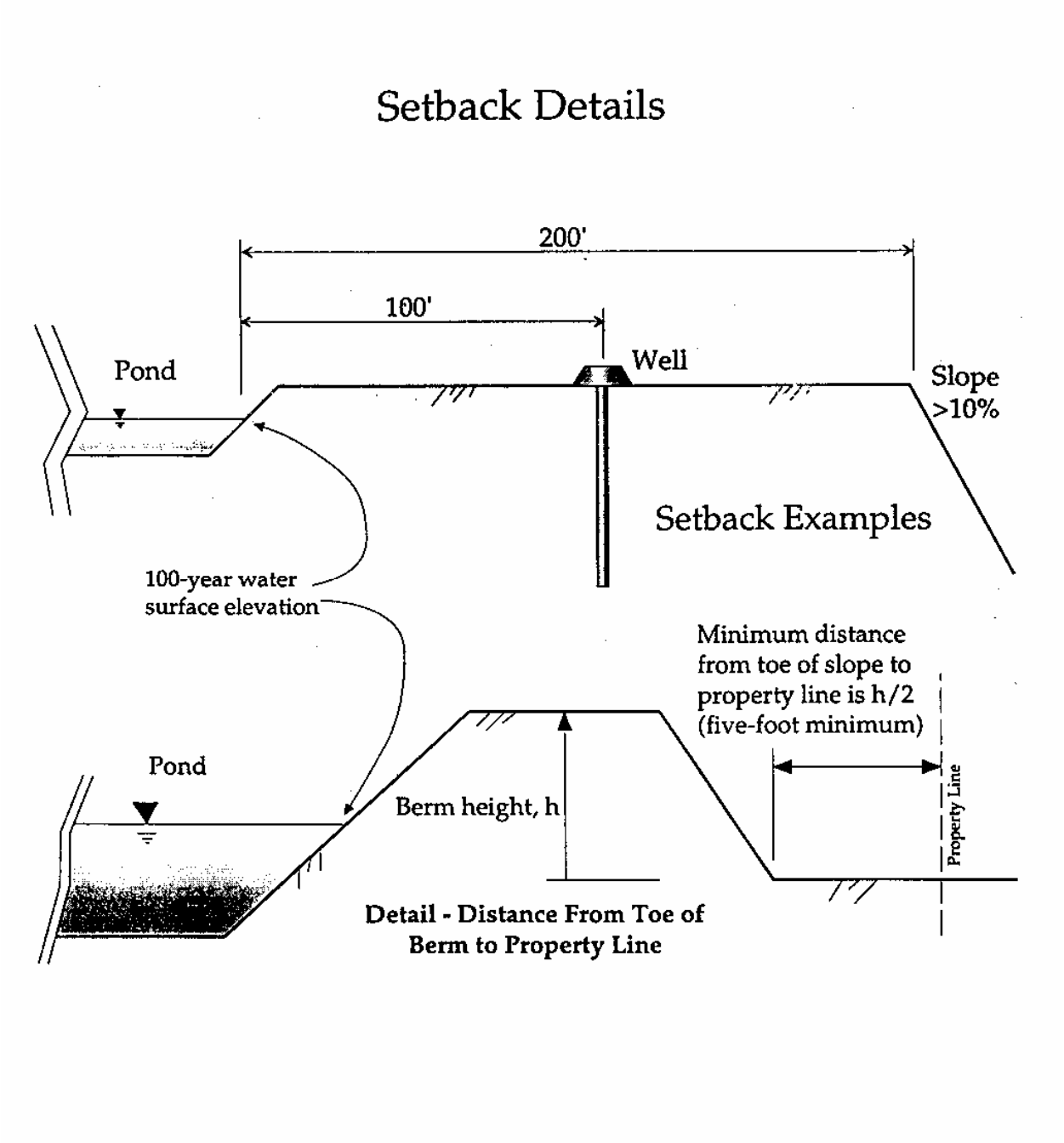
- All ponds shall have an emergency overflow spillway or structure designed to convey the 100- year, 24-hour design storm for post-development site conditions, assuming the pond is full to the overflow spillway or structure crest. The overflow shall be designed to convey these extreme event peak flows around the berm structure for discharge into the downstream conveyance system. The overflow shall be designed and sited to protect the structural integrity of the berm. This will assure that catastrophic failure of the berm is avoided, property damage is avoided, and water quality of downstream receiving water bodies is protected (see **Exhibit 2-20**).
- The subgrade of the spillway shall be set at or above the 100-year overflow elevation of the control structure. The spillway shall be located to direct overflows safely towards the downstream conveyance system and shall be located in existing soil wherever feasible. The emergency overflow spillway shall be armored with riprap or other flow-resistant material that will protect the embankment and minimize erosion. Riprap shall be designed in conformance with **Section 2.8** and shall extend to the toe of each face of the berm embankment. The emergency overflow spillway weir section shall be designed for the maximum design storm event for post-development conditions, using the following formula:

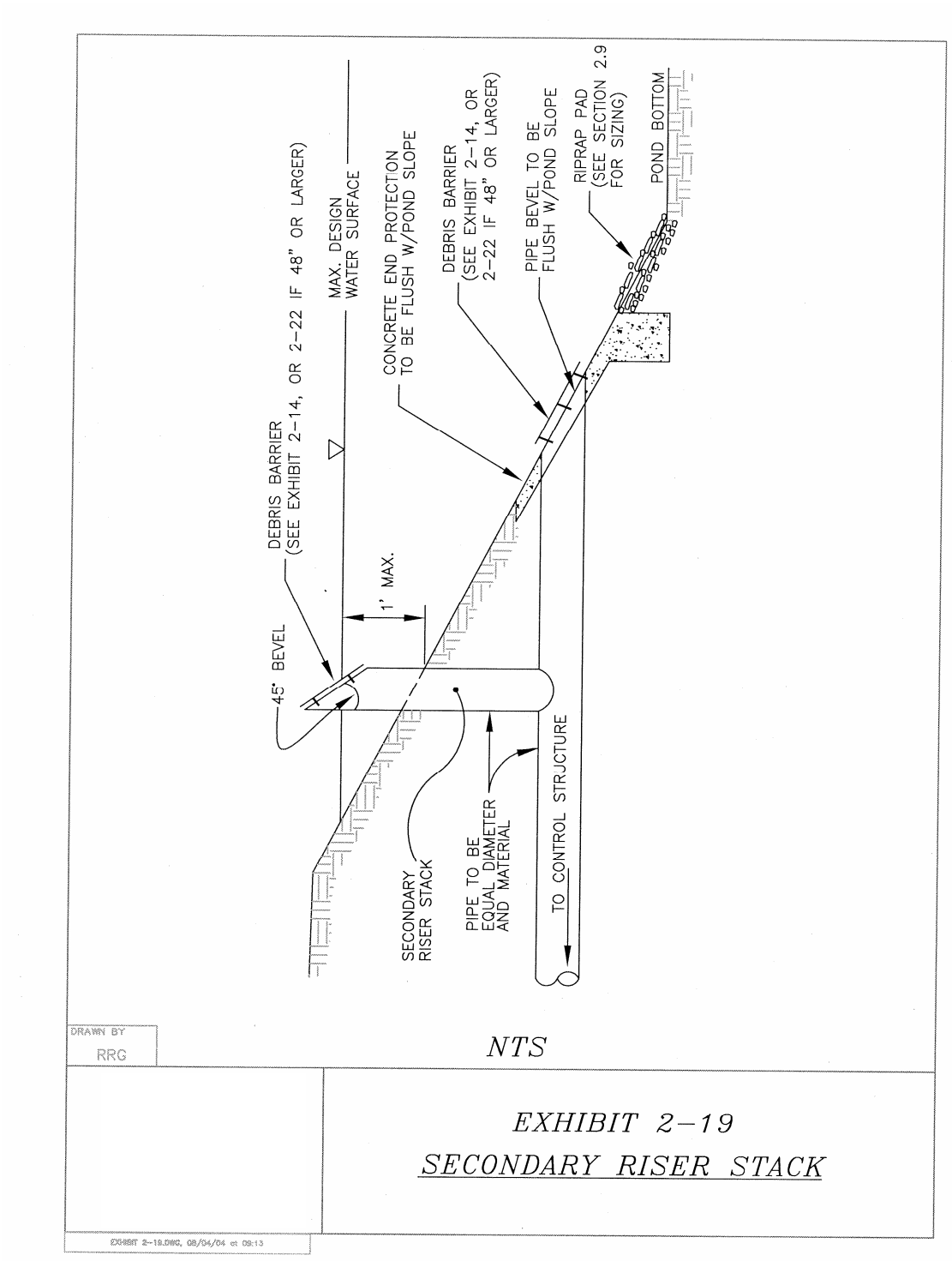
$$L = \frac{Q_{100}}{3.21H^{1.5}} - 2.4\,H$$

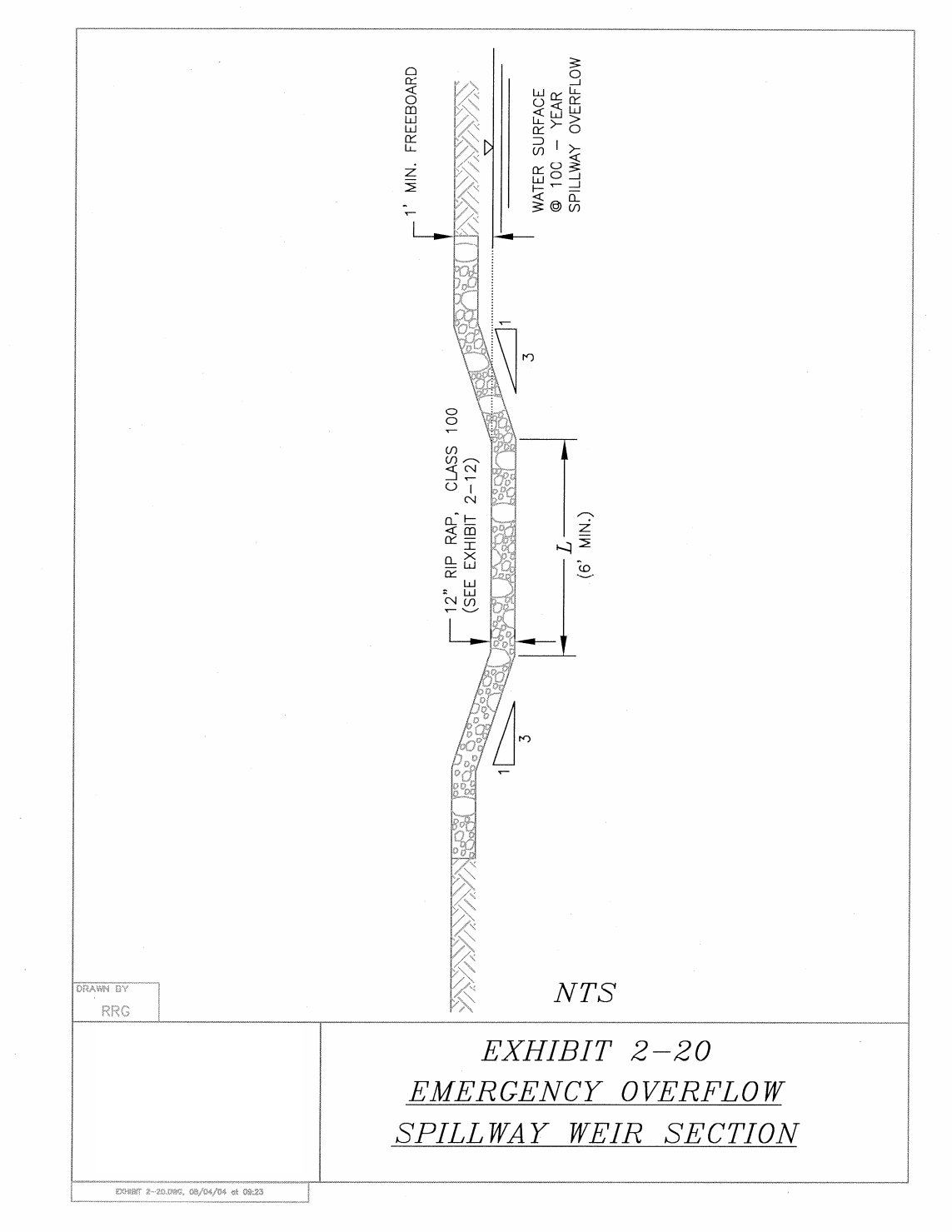
where:

L	=	Length of bottom of weir, feet
Q_{100}	=	100-year post-development flow rate, cfs
H	=	Height of emergency overflow water surface, feet

EXHIBIT 2-18


Setback Details
200'
100'
Pond
Well
Slope
>10%
Setback Examples
100-year water
surface elevation
Minimum distance
from toe of slope to
property line is h/2
(five-foot minimum)
Pond
Berm height, h
Property Line
Detail - Distance From Toe of
Berm to Property Line


DEBRIS BARRIER
(SEE EXHIBIT 2-14, OR 2-22 IF 48" OR LARGER)
MAX. DESIGN
WATER SURFACE
CONCRETE END PROTECTION
TO BE FLUSH W/POND SLOPE
DEBRIS BARRIER
(SEE EXHIBIT 2-14, OR
2-22 IF 48" OR LARGER)
PIPE BEVEL TO BE
FLUSH W/POND SLOPE
RIPRAP PAD
(SEE SECTION 2.9
FOR SIZING)
POND BOTTOM
1' MAX.
45° BEVEL
SECONDARY
RISER STACK
PIPE TO BE
EQUAL DIAMETER
AND MATERIAL
TO CONTROL STRUCTURE
DRAWN BY
RRG
NTS
EXHIBIT 2-19
SECONDARY RISER STACK
EXHIBIT 2-19.DWG, 08/04/04 at 09:13

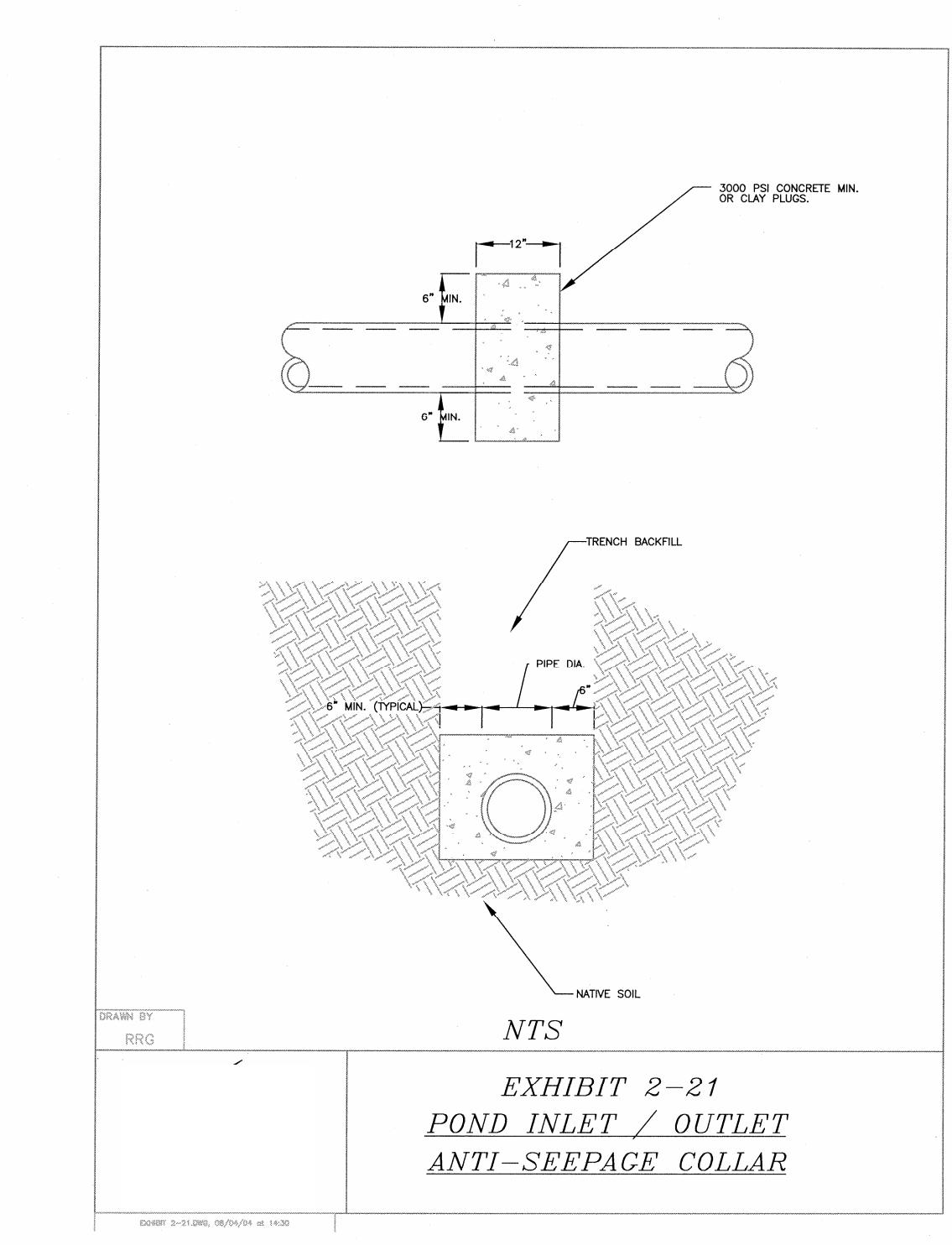


Embankment/Soil Stabilization:

- Pond berm embankments shall be designed by a civil engineer licensed in the State of Oregon.
- Pond berm embankments shall be constructed on native consolidated soil (or compacted and stable fill soil) that is free of loose surface soil materials, roots, and other organic debris. Topsoil will be required over the consolidated soil to support required plantings.
- Pond berm embankments shall be constructed by excavating a key equal to 50 percent of the berm embankment cross-sectional height and width measured through the center of the berm. (Note: A key in a berm is an excavated trench below the berm filled with soil material used to make the berm. It acts to "key" the berm into the native soil to prevent it from sliding.)
- The berm embankment shall be constructed of compacted soil (95 percent maximum dry density, Modified Proctor Method per ASTM D1557) placed in 6- to 8-inch lifts with hand-held equipment, or 10- to 12-inch lifts with heavy equipment.
- Anti-seepage collars shall be placed on outflow pipes in berm embankments impounding water greater than 8 feet in depth **(**see **Exhibit 2-21).**
- During construction, exposed earth on the pond side slopes shall be sodden or seeded with appropriate seed mixture. Establishment of protective vegetative cover shall be ensured with appropriate surface-protection best management practices (BMPs) and reseeded as necessary.
- Pond embankments shall be constructed with a maximum (i.e. steepest) slope of 3H: 1V on the upstream and downstream face. Side slopes **within** the pond shall be sloped no steeper than 3H: 1V. The use of retaining walls in ponds requires pre-approval from the City. Retaining walls shall not exceed one-third of the circumference of the pond. Detailed structural design calculations must be submitted with every retaining wall proposal.
- Pond berm embankments 6 feet or less in height including freeboard, measured through the center of the berm, shall have a minimum top width of 6 feet, or as recommended by a geotechnical engineer.
- Where maintenance access is provided along the top of berm, the minimum width of the top of berm shall be at least 15 feet.

For public ponds, the following additional design criteria shall apply:

- Two staff gauges shall be installed at opposite ends of the bottom of the pond, to enable maintenance staff to measure the depth of accumulated silts.


3000 PSI CONCRETE MIN.
OR CLAY PLUGS.
12"
6" MIN.
6" MIN.
TRENCH BACKFILL
PIPE DIA.
6"
6" MIN. (TYPICAL)
NATIVE SOIL
DRAWN BY
RRG
NTS
EXHIBIT 2-21
POND INLET / OUTLET
ANTI-SEEPAGE COLLAR
EXHIBIT 2-21.DWG, 08/04/04 at 14:30

Fencing and Signage: Fences are required for all City-maintained ponds with a permanent or temporary pool greater than 18 inches deep, interior side slopes steeper than 3H: 1V, or any walls/bulkheads greater than 24 inches high. Generally, a pond with gently sloping sides (less than 3:1) and including a 10-foot-wide safety bench around the facility at the point of slope transition does not require a fence. Applicants can request the City Engineer's approval to use fencing if there are safety concerns.

For City-maintained facilities where fencing is not required, the applicant must have City approval to use fencing. Approval will be granted only if there is no practical alternative. If fencing is required or approved, the design shall address screening requirements.

Fencing for privately owned facilities is at the discretion of the owner. The owner may, however, want to use the criteria for City-maintained facilities.

For both private and City-maintained facilities where fencing is used, fences shall be at least 6 feet high. The 6-foot height may not be required in situations where fences are not needed to prevent climbing (e.g., on steep slopes to prevent slipping). For City-maintained facilities, a minimum of one vehicular locking access gate shall be provided. It shall be 10 feet wide, consisting of two swinging sections each 5 feet wide. At least one pedestrian gate shall be provided, with a minimum 4-foot width.

Fencing materials shall be complementary to the site design. Chain link may only be used with special approval from City Engineer.

Wet and Extended Wet Detention Permanent Pool Sizing: The permanent pool (or "dead") storage volume, V_{pond}, is equivalent to twice the runoff volume generated by a storm of 0.939 inches over 24 hours (NRCS Type 1A rainfall distribution). This volume can be approximated using the following formula:

Volume = 2 * (2,276 * Impervious Acreage)

Volume = permanent pool volume, cubic feet
Impervious Acreage = area of impervious surfaces to manage, acres

EXAMPLE

A 20-acre site is to be developed. After development, the site will be 60 percent impervious. What is the required volume for a wet pond to meet pollution reduction requirements?

For the post-development condition, the total area is 20 acres and the impervious area has increased to 60 percent, or 12 acres:

Permanent Pool Volume = 2 * (2,276 * 12) = 54,624 cubic feet

Flow Control for Extended Wet Detention and Dry Detention Ponds: To restrict flow rates exiting the pond to those required by **Section 1.6.2**, a control structure designed in accordance with **Section 2.5** must be used. For extended wet detention ponds, this control structure must be located above the permanent pool elevation. The outlet orifice shall be designed to minimize clogging (see **Section 2.5: Control Structures**).

Landscaping: Shrubs and wetland plantings shall be designed to minimize solar exposure of open water areas. Trees or other appropriate vegetation shall be located around the east, south, and west sides of a facility to maximize shading. Reducing solar exposure has two benefits: it helps reduce heat gain in water before discharging to a receiving water, and it helps maintain a healthy and aesthetic pond condition, reducing algae blooms and the potential for anaerobic conditions to develop.

Facility area is equivalent to the area of the pond, including bottom and side slopes, plus a 10-foot buffer around the pond. Minimum plant material quantities per **250** square feet of the facility area are as follows:

1 - Evergreen or deciduous tree:
- Evergreen trees: Minimum height: 6 feet
- Deciduous trees: Minimum caliper: 1 ½ inches at 6 inches above base.

4 - Large shrubs/small trees: 3-gallon containers or equivalent.

6 - Shrubs/large grass-like plants: 1-gallon containers or equivalent

Ground cover plants: 1 per 12 inches on center, triangular spacing, for the ground cover planting area only, unless seed or sod is specified. Minimum container: 4-inch pot. At least 50 percent of the facility shall be planted with grasses or grass-like plants.

Wetland plants: 1 per 2 square feet of a pond emergent plant zone. The emergent plant zone shall be at least 25 percent of the total pond water surface area.

Wildflowers, native grasses, and ground covers used for City maintained facilities shall be designed not to require mowing. Where mowing cannot be avoided, facilities shall be designed to require mowing no more than once or twice annually. Turf and lawn areas are not allowed for City maintained facilities; any exceptions will require City Engineer approval.

Checklist of minimal information to be shown on the permit drawings:

(Additional information may be required on the drawings during permit review, depending on individual site conditions.)

1) Facility dimensions and setbacks from property lines and structures
2) Profile view of facility, including typical cross-sections with dimensions
3) Growing medium specification
4) Filter fabric specification (if applicable)
5) All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection
6) Landscaping plan

Inspection requirements and schedule: The following table shall be used to determine which stormwater facility components require City inspection, and when the inspection shall be requested:

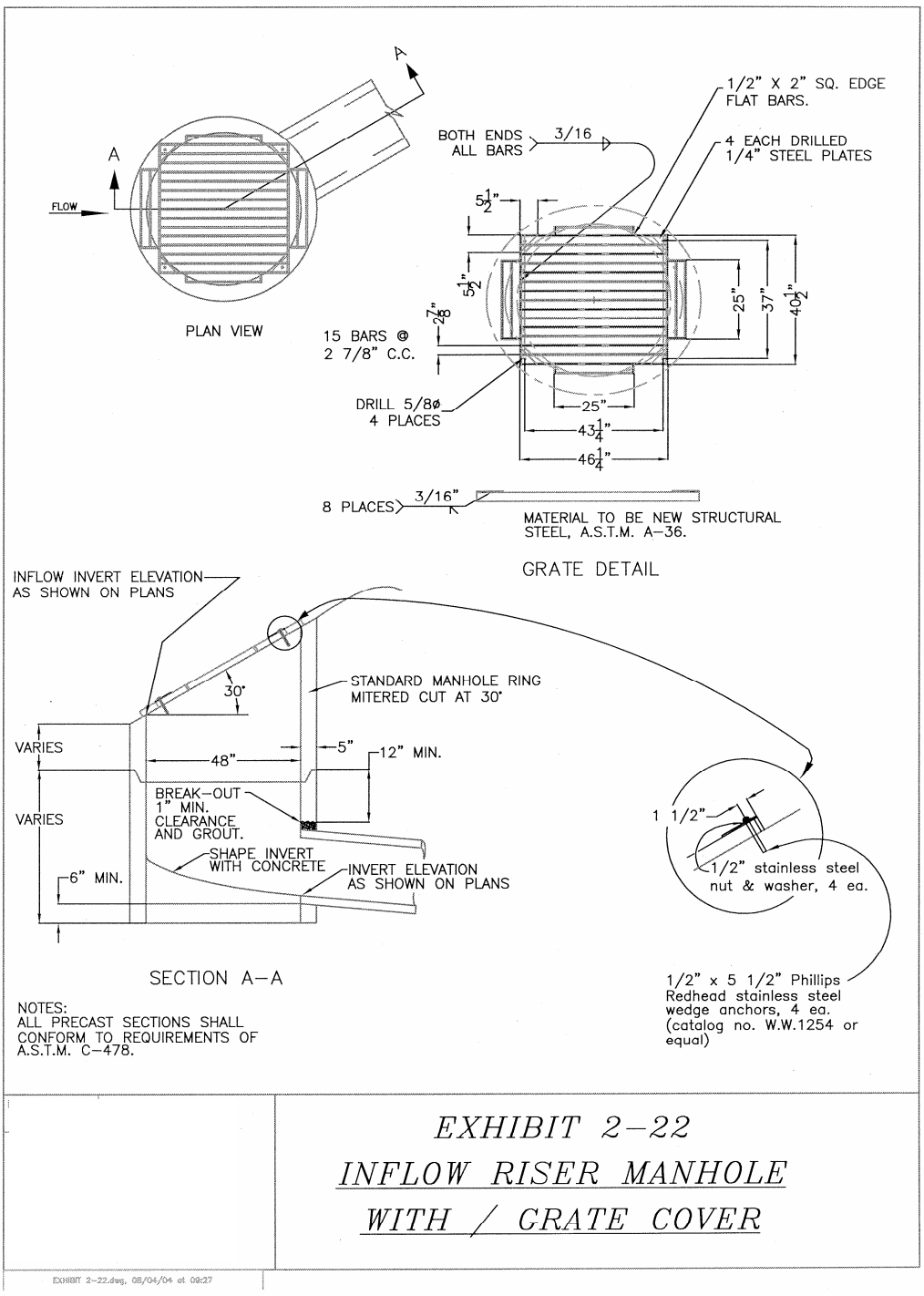
Facility Component	Inspection Requirement
Pond grading	Call for inspection
Piping	Call for inspection
Control (orifice) structure for extended wet detention and dry detention ponds	Call for inspection
Filter fabric or lining (if applicable)	
Growing medium	
Plantings	Call for inspection

Operations and Maintenance requirements: See **Chapter 3.0**.

*** Link to wet, extended wet detention, & dry detention pond O&M form**

Additional photos and drawings:

*** Link to wet and extended wet detention pond photos**
*** Link to wet and extended wet detention pond drawings**
*** Link to dry detention pond photos**
*** Link to dry detention pond drawings**


A
A
FLOW
PLAN VIEW
1/2" X 2" SQ. EDGE FLAT BARS.
BOTH ENDS ALL BARS
3/16
4 EACH DRILLED 1/4" STEEL PLATES
5 1/2"
5 1/2"
2 7/8"
15 BARS @ 2 7/8" C.C.
DRILL 5/8ø 4 PLACES
25"
37"
40 1/2"
25"
43 1/4"
46 1/4"
8 PLACES
3/16"
MATERIAL TO BE NEW STRUCTURAL STEEL, A.S.T.M. A-36.
GRATE DETAIL
INFLOW INVERT ELEVATION AS SHOWN ON PLANS
30°
STANDARD MANHOLE RING MITERED CUT AT 30°
VARIES
48"
5"
12" MIN.
VARIES
BREAK-OUT 1" MIN. CLEARANCE AND GROUT.
SHAPE INVERT WITH CONCRETE
INVERT ELEVATION AS SHOWN ON PLANS
6" MIN.
SECTION A-A
NOTES:
ALL PRECAST SECTIONS SHALL CONFORM TO REQUIREMENTS OF A.S.T.M. C-478.
1 1/2"
1/2" stainless steel nut & washer, 4 ea.
1/2" x 5 1/2" Phillips Redhead stainless steel wedge anchors, 4 ea. (catalog no. W.W.1254 or equal)
EXHIBIT 2-22
INFLOW RISER MANHOLE
WITH / GRATE COVER
EXHIBIT 2-22.dwg, 08/04/04 at 09:27

Constructed Treatment Wetland

Stormwater Management Goals Achieved		Acceptable Sizing Methodologies
√	Pollution Reduction……..	PRES
√	Flow Control……..……	PRES

SIM=Simplified Approach, PRES= Presumptive Approach, PERF= Performance Approach

Notes: 1) Wetlands can be used to manage stormwater from any type of impervious surface.

Description: A wetland is an area inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Jurisdictional wetlands include swamps, marshes, bogs, and similar areas except those constructed as pollution reduction or flow control facilities. The Corps of Engineers and Division of State Lands make specific wetland designations. Constructed treatment wetlands are wetlands designed and constructed for the specific purpose of providing stormwater management. Unlike natural wetlands, constructed treatment wetlands are not regulated by the Corps of Engineers and the Division of State Lands.

Wetlands remove pollutants through several treatment processes, including sedimentation, filtration, and biological uptake. When enough volume is provided, constructed treatment wetlands can also provide a significant level of flow control.

Design Criteria: To receive pollution reduction credit, the wet portion or permanent pool of the wetland shall be equal to that required for wet ponds, or the residence time of the stormwater volume (calculated as the pollution reduction design storm volume divided by the average facility outflow rate) shall be no less than 36 hours. A design team with experience in hydrology, wetland plants, and engineering will be needed to develop a successful wetland pollution reduction facility. A water budget analysis shall be performed with the design of the facility.

Sizing: Drainage area to be served shall be no less than 10 acres. To meet pollution reduction requirements, dead storage within the wetland must equal or exceed wet pond dead storage criteria. To meet flow control requirements, a detailed hydraulic analysis must be performed by a Professional Engineer, showing compliance with flow control standards presented in **Section 1.6.2**. For stormwater report requirements, see **Exhibit 2-2**.

Geometry: The configuration of a constructed wetland shall be tailored to each site, rather than limited to one design. Major elements of a wetland can include channels or trenches, shallow marshes, and deeper ponded areas. These elements shall be combined to take advantage of the site topography. Maximum slopes within the wetland area shall be 20%, and maximum slopes of surrounding land shall not exceed 10%. All wetland design shall address habitat, planting, and aesthetic issues.

1) The volume of water to be treated shall be allocated over the treatment area of the facility as follows:

Component	**Percent of Design Volume** (approx.)	**Percent of Facility Surface Area** (approx.)
Forebay	10	5
Micropool	10	5
Deep water (> 18″)	50	40
Deep wetland (6″-18″)	20	25
Shallow wetland (<6″)	10	25

Definitions:

Forebay: A relatively deep zone placed where influent water discharges to a stormwater wetland. It traps coarse sediments, reduces incoming velocity, and helps distribute runoff evenly over the wetland.

Micropool: A deep (4 to 6 feet) pool placed at the outlet of a stormwater wetland forebay.

Deep-water: The area within a stormwater wetland that has a water depth greater than 18 inches.

Deep wetland: The area within a stormwater wetland that has a water depth between 6 and 18 inches.

Shallow wetland: The area within a stormwater wetland that has a water depth less than 6 inches.

2) The minimum length-to-width ratio shall be 3:1, unless otherwise approved by the City. If area constraints make this ratio unworkable, baffles, islands, or peninsulas may be installed, with City approval, to increase the flow path and prevent short-circuiting.

3) Where wetland vegetation is to be planted, side slopes shall be no steeper than 5:1. Wetland plant selection shall be consistent with anticipated hydrology.

4) Access routes to the wetland for maintenance purposes must be shown on the plans. Public wetlands will need to provide a minimum 8-foot wide access route, not to exceed 10 percent in slope.

Flow:

1) Flow velocity through the wetland shall average less than 0.01 feet per second for the water quality design storm event (see **Section 1.5.2**). If natural slope does not allow for this velocity, berms shall be used to create ponded benches.

2) Flow through the wetland shall be distributed as uniformly as possible across the marsh and ponded section.

Forebay:

1) The forebay area shall be established along the wetland inflow points to capture sediment. The forebay shall have a water depth of about 3 feet and have at least 10 percent and up to 25 percent of the total treatment wetland volume.

An overflow mechanism to an approved conveyance/destination method per **Section 1.4** will be required.

Soil Suitability: Constructed treatment wetlands are appropriate for NRCS type C and D soils. Topsoil shall be used within the top 12 inches of the facility, or the soil shall be amended per Appendix F to support plant growth.

Setbacks: Required setback from property lines is 5 feet, and 10 feet from building foundations. Infiltration basins shall meet the following setback requirements from downstream slopes: minimum of 100 feet from slopes of 10%; add 5 feet of setback for each additional percent of slope up to 30%; 200-foot setback for slopes of 30%; infiltration trenches shall not be used where slopes exceed 30%.

Landscaping: Shrubs and wetland plantings shall be designed to minimize solar exposure of open water areas. Trees or other appropriate vegetation shall be located around the east, south, and west sides of a facility to maximize shading. Reducing solar exposure has two benefits: it helps reduce heat gain in water before discharging to a receiving water, and it helps maintain a healthy and aesthetic pond condition, reducing algae blooms and the potential for anaerobic conditions to develop.

Facility area is equivalent to the area of the wetland, including bottom and side slopes, plus a 10-foot buffer around the wetland. Minimum plant material quantities per **200** square feet of the facility area are as follows:

1 - Evergreen or deciduous tree:
- Evergreen trees: Minimum height: 6 feet
- Deciduous trees: Minimum caliper: 1 ½ inches at 6 inches above base.

4 - Large shrubs/small trees 3-gallon containers or equivalent.

6 - Shrubs/large grass-like plants 1-gallon containers or equivalent

Ground cover plants: 1 per 12 inches on center, triangular spacing, for the ground cover planting area only, unless seed or sod is specified. Minimum container: 4-inch pot. At least 50 percent of the facility shall be planted with grasses or grass-like plants.

Wetland plants: 1 per 2 square feet of a pond emergent plant zone. The emergent plant zone shall be at least 25 percent of the total pond water surface area.

Wildflowers, native grasses, and ground covers used for City maintained facilities shall be designed not to require mowing. Where mowing cannot be avoided, facilities shall be designed to require mowing no more than once or twice annually. Turf and lawn areas are not allowed for City maintained facilities; any exceptions will require approval by the City Engineer.

***Link to Recommended Plants**

For public constructed treatment wetlands, the following additional design criteria shall apply:

1) Two staff gauges shall be installed at opposite ends of the bottom of the wetland, to enable maintenance staff to measure the depth of accumulated silts.

2) A soil scientist, or suitably trained person working under the supervision of an Oregon licensed professional geotechnical engineer, shall inspect the soil after the system is excavated to confirm that soils remain in suitable condition for planting.

Checklist of minimal information to be shown on the permit drawings:

(Additional information may be required on the drawings during permit review, depending on individual site conditions.)

1) Facility dimensions and setbacks from property lines and structures
2) Profile view of facility, including typical cross-sections with dimensions
3) Growing medium specification
4) Filter fabric specification (if applicable)
5) All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection
6) Landscaping plan

Inspection requirements and schedule: The following table shall be used to determine which stormwater facility components require City inspection, and when the inspection shall be requested:

Facility Component	Inspection Requirement
Wetland grading	Call for inspection
Piping	Call for inspection
Filter fabric (if applicable)	
Growing medium	
Plantings	Call for inspection

Operations and Maintenance requirements: See **Chapter 3.0**.

*** Link to constructed treatment wetland O&M form**

Additional photos:

*** Link to constructed treatment wetland photos**

2.9.12 Manufactured Treatment Technology

Stormwater Management Goals Achieved	Acceptable Sizing Methodologies
√ Pollution Reduction……..	PERF
Flow Control……	NA

SIM=Simplified Approach, PRES= Presumptive Approach, PERF= Performance Approach

Notes: 1) For a list of currently accepted manufactured stormwater treatment technologies, contact the City Engineer. Manufactured stormwater treatment technologies can be used to provide pollution reduction for any impervious surface. They can be located on private property, and some are approved for use in public right-of-ways. **2)** Any facility requiring UIC permits will not be accepted by the City.

For a manufactured stormwater treatment technology to be approved for general use within the City of Grants Pass, the manufacturer must submit detailed performance testing data.

To be approved for use as a public facility, the manufacturer must also submit detailed information about the facility's design criteria, construction techniques, operation and maintenance procedures, reliability, and cost. This information will be reviewed by City Engineer, which will decide whether or not the facility can be used for public projects.

Manufactured stormwater treatment technologies on the City's approved list must be designed and constructed in accordance with the manufacturer's recommendations. The City Engineer may have also placed special design conditions on the acceptance of the technology, such as sizing requirements that go beyond the manufacturer's recommendations, which must also be followed to obtain plan approval.

In addition to design calculations shown in **Exhibit 2-2**, the following must be submitted with each manufactured stormwater treatment technology project:

1) Pollution reduction capacity of the facility
2) Flow-through conveyance capacity (i.e., how much flow can be passed through the facility without stirring up and releasing trapped pollutants)

An operations and maintenance manual must also be submitted for City Engineer review. See **Chapter 3.0** for O&M plan guidance.

Manufactured stormwater treatment technologies on the City's approved list for general use may not be capable of meeting specific TMDL requirements for certain watersheds. In that case, the treatment technology will not be accepted as a stand-alone pollution reduction facility. Rather, a pollution reduction facility that is presumed by the City Engineer to meet the TMDL requirement must be used.

For a list of currently approved manufactured stormwater treatment technologies, contact the City Engineer at (514) 474-6355.

Checklist of minimal information to be shown on the permit drawings:

(Additional information may be required on the drawings during permit review, depending on individual site conditions.)

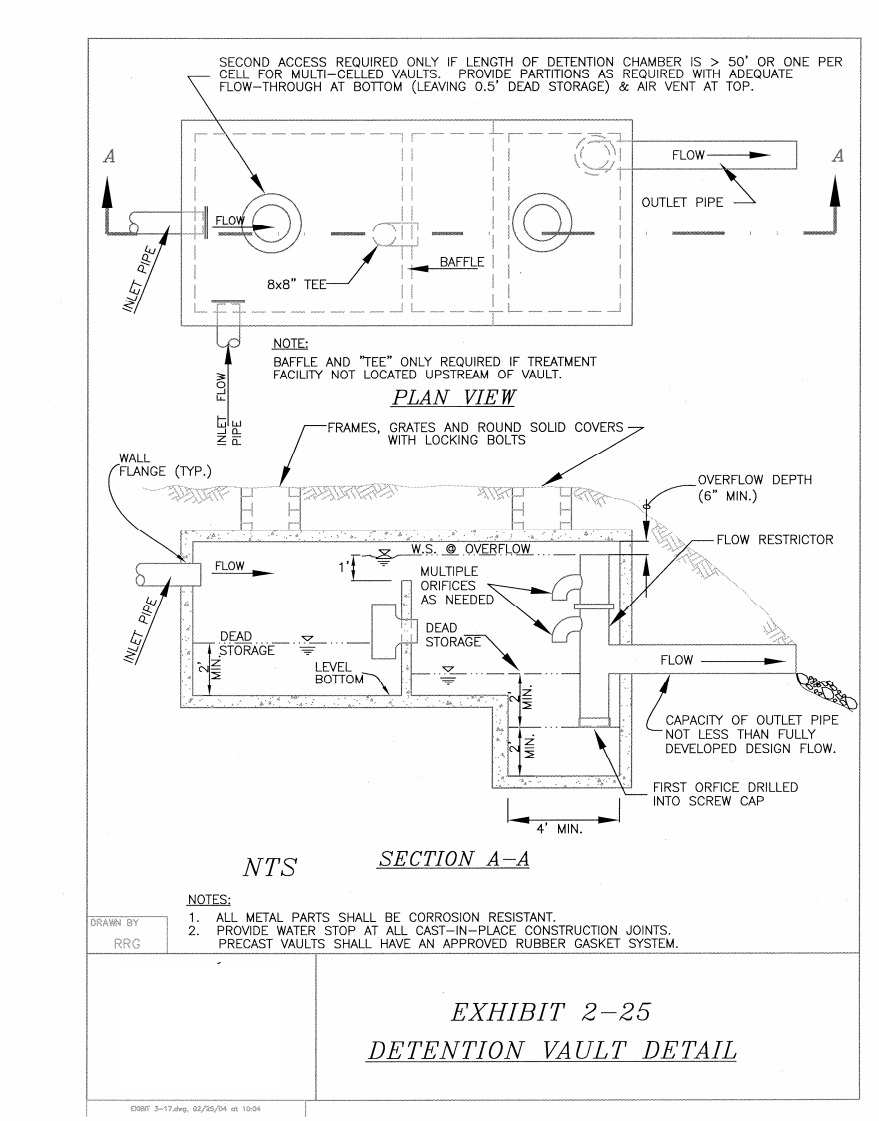
1) Facility dimensions and setbacks from property lines and structures
2) Profile view of facility, including typical cross-sections with dimensions
3) All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection

Inspection requirements and schedule: The following table shall be used to determine which stormwater facility components require City inspection, and when the inspection shall be requested:

Facility Component	Inspection Requirement
Vault excavation	
Piping	Call for inspection
Vault installation	Cal for inspection

Operations and Maintenance requirements: An operations and maintenance plan will be required, including information from the manufacturer, as per **Chapter 3.0**.

2.9.13 Structural Detention Facilities



Stormwater Management Goals Achieved		Acceptable Sizing Methodologies
	Pollution Reduction…….……..	NA
√	Flow Control…….……..	PRES

SIM=Simplified Approach, PRES= Presumptive Approach, PERF= Performance Approach

Notes: 1) See **Exhibit 2-2** for hydrologic and hydraulic calculations that must be submitted with structural detention design. Structural detention facilities may be used to provide flow control for any impervious surface type, and may be located on private property or within the public right-of-way.

Description: Structural detention facilities such as tanks, vaults, and oversized pipes provide underground storage of stormwater as part of a runoff flow control system. As with any underground structure, they must be designed not only for their function as runoff flow control facilities, but also to withstand an environment of periodic inundation, potentially corrosive chemical or electrochemical soil conditions, and heavy ground and surface loadings. They must also be accessible for maintenance. Facilities in this section must be designed using acceptable hydrologic modeling techniques (See **Section 2.3**) to meet applicable flow control requirements. Additional facilities will be required to meet applicable pollution reduction requirements.

Tanks and vaults typically do not have a built-in design feature for containing sediment, as do multi-cell ponds. When tanks or vaults are used for detention storage, therefore, either a surface sediment containment pond shall be placed upstream of the tank or vault, or the tank/vault shall be oversized to allow for the temporary accumulation of sediment. Where the tank or vault is designed to provide sediment containment, a minimum of ½ foot of dead storage shall be provided, and the tank or vault shall be laid flat.

Tanks and vaults can be used in conjunction with other detention storage facilities, such as ponds or parking lot ponds, to provide initial or supplemental storage.

Because of minimum orifice size specifications, structural flow control facilities (such as detention tanks, vaults, and oversized pipes) for projects with less than 15,000 square feet of impervious surface are not effective and will not be required. Projects with less than 15,000 square feet of impervious surface are required to use surface retention facilities to control flows. Where this is not possible, the applicant must pay the off-site management fee (See **Section 1.9**).

Design Requirements:
The following criteria apply to detention tank, vault, and oversized pipe design.

- All areas of a tank or vault shall be within 50 feet of a minimum 36-inch diameter access entry cover. All access openings shall have round, solid locking lids.
- Publicly owned detention tanks, vaults, and pipes are permitted within public rights-of-way. If developments are served with publicly operated and maintained tanks and vaults that are not located within the right-of-way, the tanks/vaults shall be located in separate open space tracts with public sewer easements that are dedicated to the City of Grants Pass. All privately owned and maintained facilities shall be located to allow easy maintenance and access. (**See Chapter 3.0**: Operation and Maintenance)
- All tanks and vaults shall be designed as flow-through systems, unless separate sediment containment is provided.

- Minimum size for a public detention pipe shall be 36 inches. If the collection system piping is designed also to provide storage, the resulting maximum water surface elevation shall maintain a minimum 1-foot of freeboard in any catch basin below the catch basin grate. Pipe capacity shall be verified using an accepted methodology approved by the City. The minimum internal height of a vault or tank shall be 3 feet, and the minimum width shall be 3 feet. The maximum depth of the vault or tank invert shall be 20 feet. Pipe material and surface treatment shall conform to the standards for detention tanks and vaults (see **Exhibits 2-23 and 2-25).**
- Detention tanks and vaults shall have a minimum of ½ foot of dead storage, unless upstream sedimentation is provided (see **Exhibits 2-23 and 2-25**).

Flow Control:

- To restrict flow rates exiting the pond to those required by **Section 1.6.2**, a control structure per **Section 2.5** must be used.

Materials and Structural Stability:

- For public facilities, pipe materials and joints shall conform to the City of Grants Pass Design Standards. For private facilities, the pipe material shall conform to the Unified Plumbing Code.
- All tanks, vaults, and pipes shall meet structural requirements for overburden support and traffic loadings, if appropriate. H-20 live loads shall be accommodated for tanks and vaults under roadways and parking areas. End caps shall be designed for structural stability at maximum hydrostatic loading conditions.
- Detention vaults shall be constructed of structural reinforced concrete (3000 psi, ASTM 405). All construction joints shall be provided with water stops.
- In soils where groundwater may induce flotation and buoyancy, measures shall be taken to counteract these forces. Ballasting with concrete or earth backfill, providing concrete anchors or other counteractive measures shall be required. Calculations shall be required to demonstrate stability.
- Tanks and vaults shall be placed on stable, consolidated native soil with suitable bedding. Tanks and vaults shall not be allowed in fill slopes, unless a geotechnical analysis is performed for stability and construction practices.

Checklist of minimal information to be shown on the permit drawings:

(Additional information may be required on the drawings during permit review, depending on individual site conditions.)

1) Facility dimensions and setbacks from property lines and structures
2) Profile view of facility, including typical cross-sections with dimensions
3) All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection

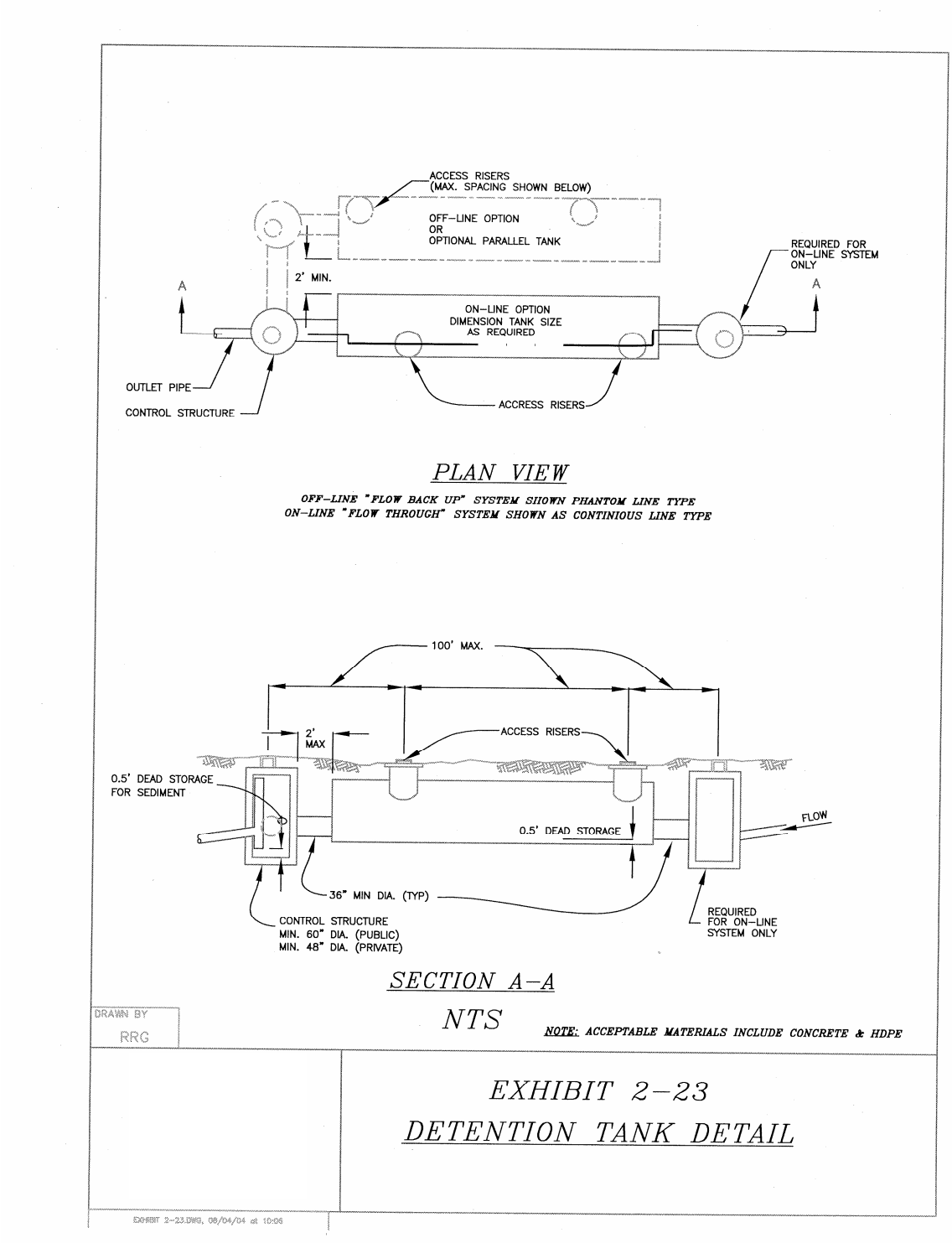
Inspection requirements and schedule: The following table shall be used to determine which stormwater facility components require City inspection, and when the inspection shall be requested:

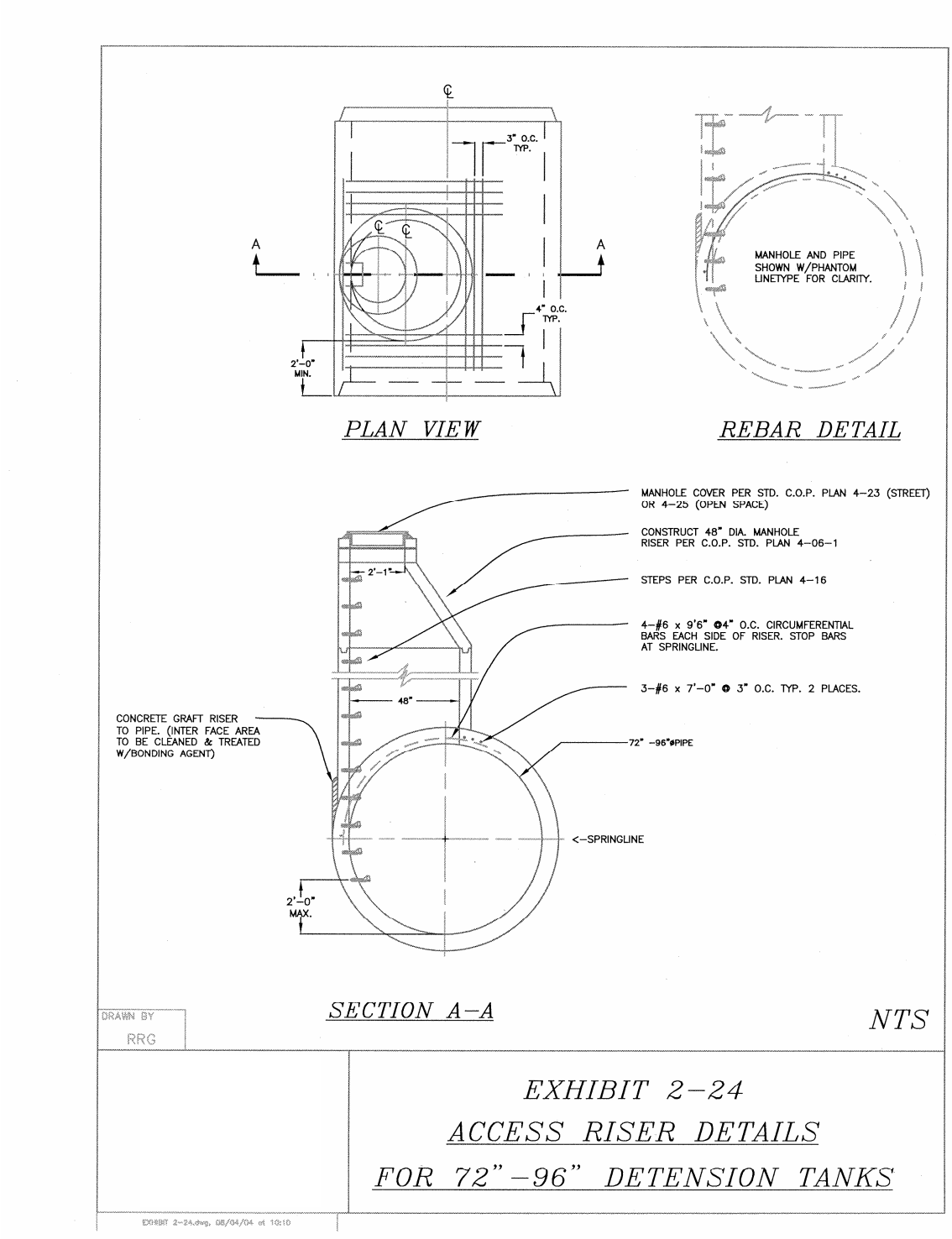
Facility Component	Inspection Requirement
Vault excavation	
Piping	Call for inspection
Vault installation	Call for inspection
Control structure (orifice structure)	Call for inspection

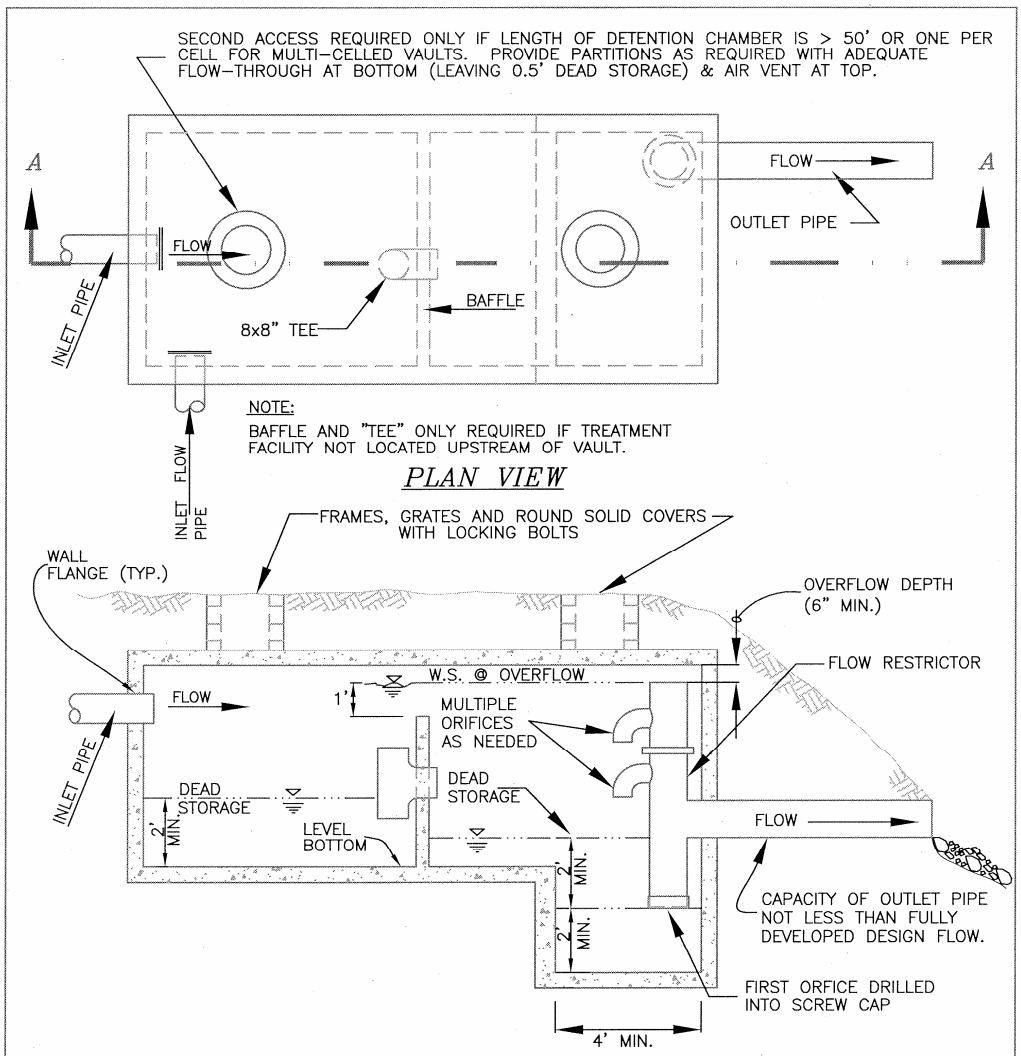
OPERATIONS AND MAINTENANCE REQUIREMENTS: See Chapter 3.0.

*** Link to tank, vault, and oversized pipe O&M form**

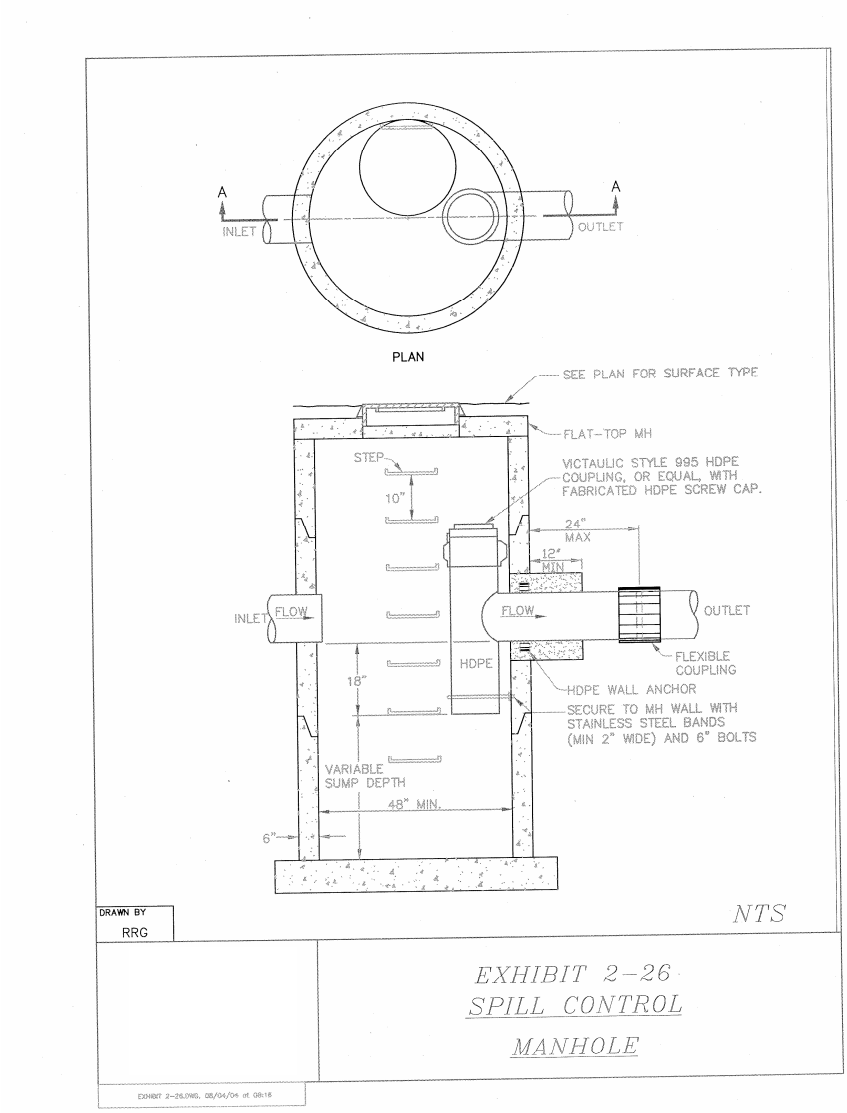
STORMWATER REPORT REQUIREMENTS: See **Exhibit 2-2**.


ACCESS RISERS
(MAX. SPACING SHOWN BELOW)
OFF-LINE OPTION
OR
OPTIONAL PARALLEL TANK
REQUIRED FOR
ON-LINE SYSTEM
ONLY
2' MIN.
A
A
ON-LINE OPTION
DIMENSION TANK SIZE
AS REQUIRED
OUTLET PIPE
CONTROL STRUCTURE
ACCRESS RISERS
PLAN VIEW
OFF-LINE "FLOW BACK UP" SYSTEM SHOWN PHANTOM LINE TYPE
ON-LINE "FLOW THROUGH" SYSTEM SHOWN AS CONTINIOUS LINE TYPE
100' MAX.
2'
MAX
ACCESS RISERS
0.5' DEAD STORAGE
FOR SEDIMENT
FLOW
0.5' DEAD STORAGE
36" MIN DIA. (TYP)
CONTROL STRUCTURE
MIN. 60" DIA. (PUBLIC)
MIN. 48" DIA. (PRIVATE)
REQUIRED
FOR ON-LINE
SYSTEM ONLY
SECTION A-A
NTS
DRAWN BY
RRG
NOTE: ACCEPTABLE MATERIALS INCLUDE CONCRETE & HDPE
EXHIBIT 2-23
DETENTION TANK DETAIL
EXHIBIT 2-23.DWG, 08/04/04 at 10:06


℄
3" o.c.
TYP.
A
A
℄ ℄
4" o.c.
TYP.
2'-0"
MIN.
PLAN VIEW
MANHOLE AND PIPE
SHOWN W/PHANTOM
LINETYPE FOR CLARITY.
REBAR DETAIL
MANHOLE COVER PER STD. C.O.P. PLAN 4-23 (STREET)
OR 4-25 (OPEN SPACE)
CONSTRUCT 48" DIA. MANHOLE
RISER PER C.O.P. STD. PLAN 4-06-1
STEPS PER C.O.P. STD. PLAN 4-16
4-#6 x 9'6" @4" O.C. CIRCUMFERENTIAL
BARS EACH SIDE OF RISER. STOP BARS
AT SPRINGLINE.
3-#6 x 7'-0" @ 3" O.C. TYP. 2 PLACES.
2'-1"
48"
CONCRETE GRAFT RISER
TO PIPE. (INTER FACE AREA
TO BE CLEANED & TREATED
W/BONDING AGENT)
72" -96"ϕPIPE
<-SPRINGLINE
2'-0"
MAX.
SECTION A-A
NTS
DRAWN BY
RRG
EXHIBIT 2-24
ACCESS RISER DETAILS
FOR 72"-96" DETENSION TANKS
EXHIBIT 2-24.dwg, 08/04/04 at 10:10


SECOND ACCESS REQUIRED ONLY IF LENGTH OF DETENTION CHAMBER IS > 50' OR ONE PER CELL FOR MULTI-CELLED VAULTS. PROVIDE PARTITIONS AS REQUIRED WITH ADEQUATE FLOW-THROUGH AT BOTTOM (LEAVING 0.5' DEAD STORAGE) & AIR VENT AT TOP.
A
A
FLOW
OUTLET PIPE
FLOW
INLET PIPE
8x8" TEE
BAFFLE
NOTE:
BAFFLE AND "TEE" ONLY REQUIRED IF TREATMENT FACILITY NOT LOCATED UPSTREAM OF VAULT.
INLET FLOW PIPE
PLAN VIEW
FRAMES, GRATES AND ROUND SOLID COVERS WITH LOCKING BOLTS
WALL FLANGE (TYP.)
OVERFLOW DEPTH (6" MIN.)
FLOW RESTRICTOR
W.S. @ OVERFLOW
1'
FLOW
MULTIPLE ORIFICES AS NEEDED
INLET PIPE
DEAD STORAGE
DEAD STORAGE
2' MIN.
LEVEL BOTTOM
FLOW
2' MIN.
2' MIN.
CAPACITY OF OUTLET PIPE NOT LESS THAN FULLY DEVELOPED DESIGN FLOW.
FIRST ORFICE DRILLED INTO SCREW CAP
4' MIN.
NTS
SECTION A-A
NOTES:
1. ALL METAL PARTS SHALL BE CORROSION RESISTANT.
2. PROVIDE WATER STOP AT ALL CAST-IN-PLACE CONSTRUCTION JOINTS. PRECAST VAULTS SHALL HAVE AN APPROVED RUBBER GASKET SYSTEM.
DRAWN BY
RRG
EXHIBIT 2-25
DETENTION VAULT DETAIL
EXBIT 3-17.dwg, 02/25/04 at 10:04

2.9.14 Spill Control Manhole



Stormwater Management Goals Achieved		Acceptable Sizing Methodologies
√	Pollution Reduction[1] (Oil Only)……..	PRES[1]
	Flow Control……	NA

SIM=Simplified Approach, PRES= Presumptive Approach, PERF= Performance Approach

Notes: 1) Spill control manholes receive credit for oil removal only. They may be used to remove oil from parking lots and other vehicular access areas.

Description: Spill control manholes rely on passive mechanisms that take advantage of oil being lighter than water. Oil rises to the surface and can be periodically removed. They consist of a simple underground manhole with a "T" outlet designed to trap small spills. Spill control manholes will not be given credit for basic pollution reduction requirements. They must be used in conjunction with other pollution reduction systems from this chapter to meet oil control and pollution reduction requirements.

Other Options: There may be other acceptable oil controls not listed above. Applicants may propose an alternative oil control option under the performance approach. However, proposal of a new oil control will require an additional review process for approval, which may delay issuance of related building permits.

Design and Sizing Criteria:

- Spill control manholes shall be used in conjunction with an appropriately sized vegetated pollution reduction facility from this chapter to achieve 10 ppm oil effluent from the peak flow generated by the pollution reduction design storm intensity of 0.19 inches per hour. The spill control sump volume shall be 60 cubic feet *or* 20 cubic feet of sump capacity for each cubic feet per second (cfs) of peak pollution reduction design flow, whichever is greater. This treatment train configuration of multiple treatment facilities in series, when sized per the above requirements, will be presumed to meet the 10 ppm effluent design standard.

- To maintain efficiencies and reduce size, all roof drainage shall enter the stormwater system downstream of the spill control manhole, unless sized accordingly.

- Any pumping devices shall be installed downstream of the spill control manhole to prevent oil emulsification in stormwater.

- Engineered calculations are required, using the Rational Method (Q=C*I*A).

Checklist of minimal information to be shown on the permit drawings:

(Additional information may be required on the drawings during permit review, depending on individual site conditions.)

1) Facility dimensions and setbacks from property lines and structures.
2) Profile view of facility, including typical cross-section details with dimensions. These details shall match manufacturer specifications and details.
3) All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection.

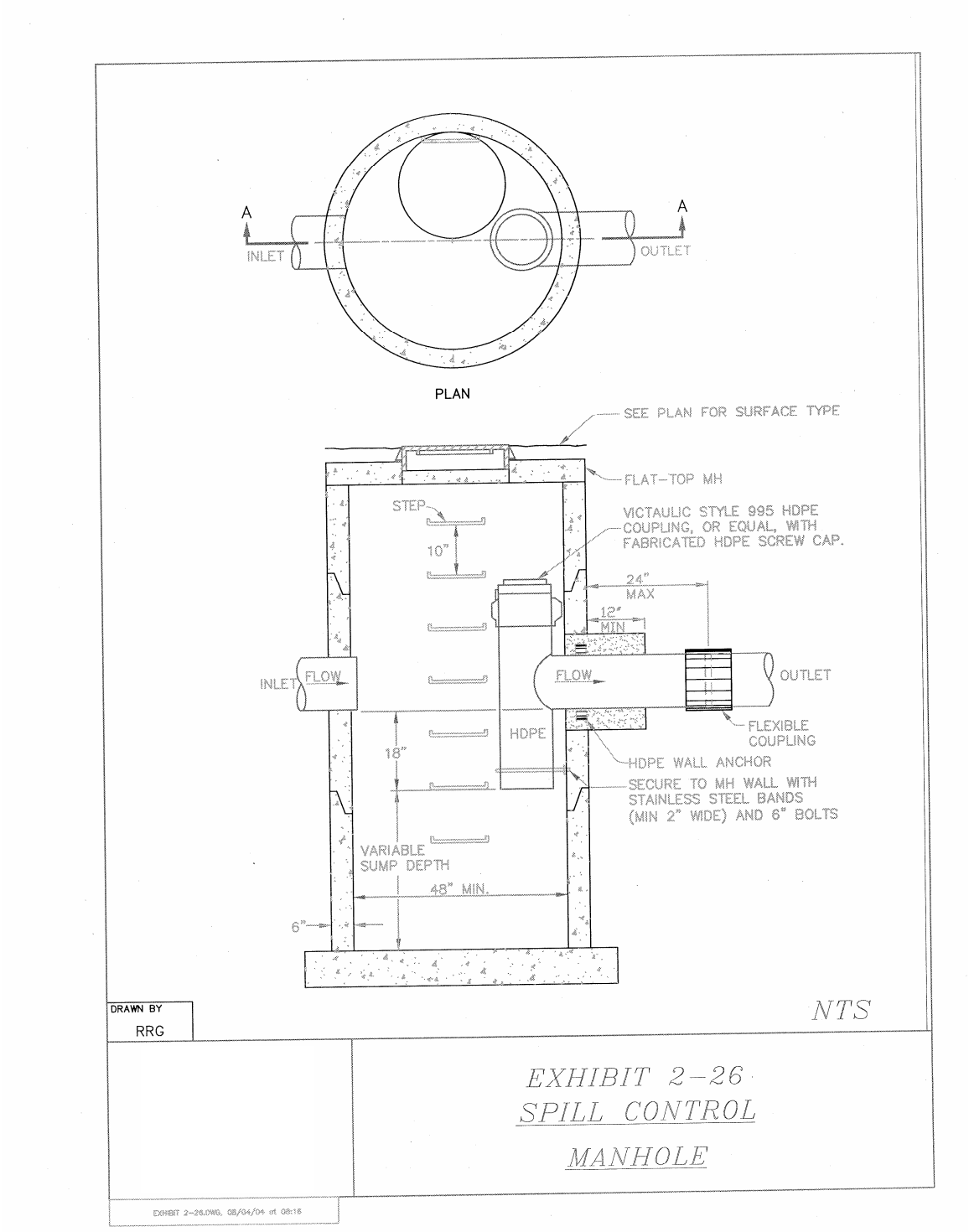
Inspection requirements and schedule: The following table shall be used to determine which stormwater facility components require City inspection, and when the inspection shall be requested:

Facility Component	Inspection Requirement
Manhole excavation	
Piping	Call for inspection
Manhole installation	Cal for inspection

OPERATIONS AND MAINTENANCE REQUIREMENTS: See Chapter 3.0.

*** Link to Spill Control Manhole O&M form**

STORMWATER REPORT REQUIREMENTS: See **Exhibit 2-2**.


A
A
INLET
OUTLET
PLAN
SEE PLAN FOR SURFACE TYPE
FLAT-TOP MH
STEP
10"
VICTAULIC STYLE 995 HDPE
COUPLING, OR EQUAL, WITH
FABRICATED HDPE SCREW CAP.
24"
MAX
12"
MIN
INLET
FLOW
FLOW
OUTLET
HDPE
FLEXIBLE
COUPLING
18"
HDPE WALL ANCHOR
SECURE TO MH WALL WITH
STAINLESS STEEL BANDS
(MIN 2" WIDE) AND 6" BOLTS
VARIABLE
SUMP DEPTH
48" MIN.
6"
DRAWN BY
RRG
NTS
EXHIBIT 2-26
SPILL CONTROL
MANHOLE
EXHIBIT 2-26.DWG, 08/04/04 at 08:16

2.9.15 Rainwater Harvesting

Stormwater Management Goals Achieved		Acceptable Sizing Methodologies
√	Pollution Reduction……..	PERF[1]
√	Flow Control…….……	PERF[1]

SIM=Simplified Approach, PRES= Presumptive Approach, PERF= Performance Approach

Notes: 1) The required water storage volume is a function of drainage area, rate of water usage, and stormwater management goal. Rainwater harvesting systems may be used to manage stormwater from rooftops and depending on the water use, other impervious surfaces, and must be located on private property.

Description: Stormwater may be collected and reused for non-potable water uses within a house or building, or for landscape irrigation purposes. Uses can include reusing water in toilets and at hose bibs. Reducing the water used from the City water system can reduce a site's water bill.

Rainwater harvesting can provide several stormwater management benefits:

- Flow control: RainwaterR harvesting can provide significant flow-reduction benefits. Depending on the size of the water storage facility and the rate of use, a significant percentage of the annual runoff volume can be reused. Where it isn't feasible to meet a development site's full flow control obligation, rainwater harvesting can be used to manage a portion of the flow and lessen the overall flow control requirement.

- Pollution reduction: As a result of the significant reduction in off-site flow volume that can be achieved, a significant reduction in the discharge of pollutants associated with stormwater can also be accomplished. Where it isn't feasible to meet a development site's full pollution reduction obligation, rainwater harvesting can be used to manage a portion of the flow and lessen the overall pollution reduction requirement.

Checklist of minimal information to be shown on the permit drawings, or included with the permit submittal package:

1) Water storage facility details and specifications
2) Pump and associated electrical details and specifications
3) Piping size, material, and placement details and specifications
4) Average daily water use documentation
5) Hydraulic calculations demonstrating compliance with stormwater management requirements (pollution and flow control)
6) Approximate setbacks from property lines and structures shall be shown
7) Overflow connection to approved stormwater destination per **Section 1.4**

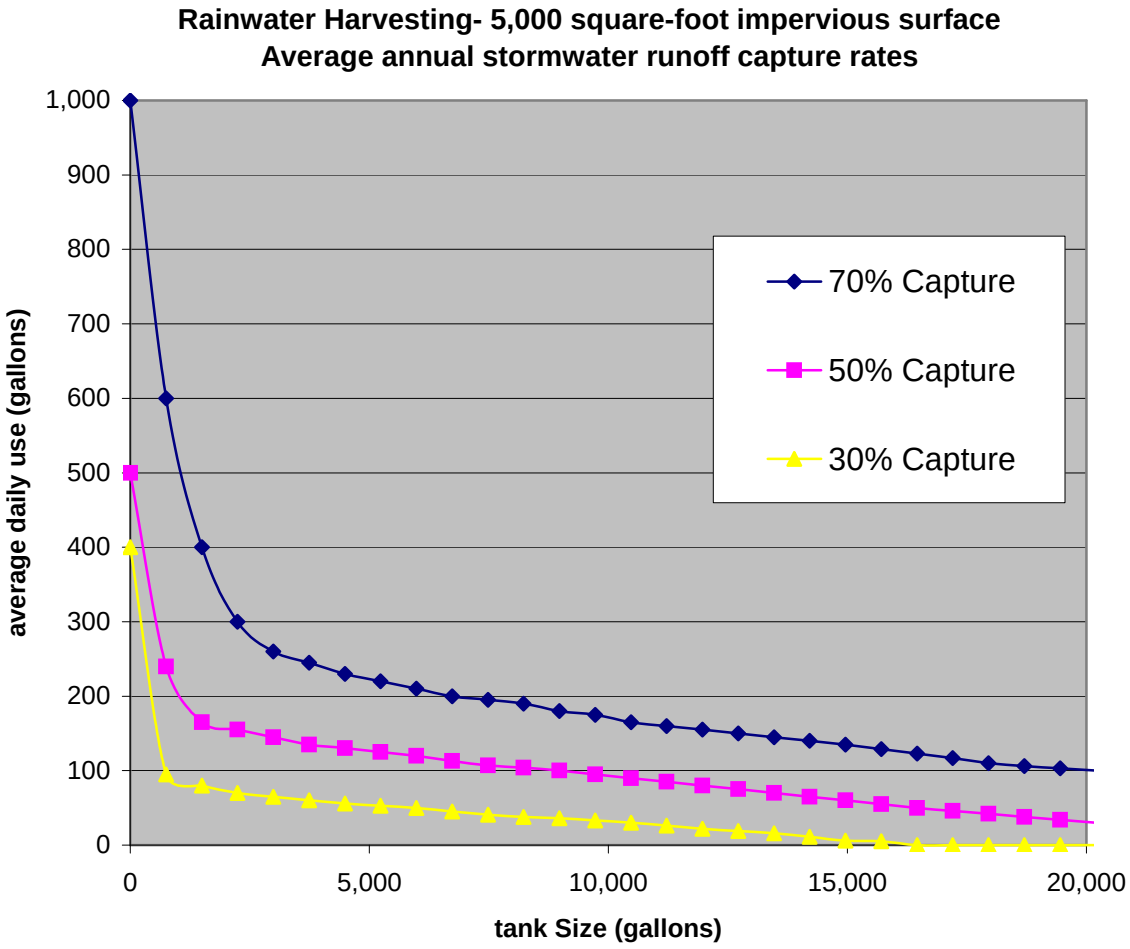
Operations and Maintenance requirements: See **Chapter 3.0**.

The following chart represents an analysis done on a 5,000 square-foot project site with 100% impervious surface. 8.5 months of 5-minute rainfall intensity data from the Fernwood rain gage in Portland was used in the analysis, which shows the relationship between water storage volume and average daily water use rate for average annual runoff capture goals of 30%, 50%, and 70%.

For example, if the stormwater management goal is 50% reduction of the annual release volume, the middle line with squares is used to show that if a 2,000-gallon tank were

used, the average daily use would need to be approximately 160 gallons per day. A larger tank would necessitate a smaller average daily use rate to achieve the same stormwater management goal of 50% annual volume reduction.

Exhibit 2-27:



Chapter 3.0
OPERATIONS & MAINTENANCE

Summary of Chapter 3.0

This chapter presents operation and maintenance (O&M) requirements for the stormwater management facilities in this manual. It includes:

3.1 Applicability of O&M requirements
3.2 O&M submittal requirements
3.2.1 for private facilities
3.2.2 for public facilities
3.3 O&M Plan Enforcement
Form O&M
Example of Form O&M
Inspection Log Sample
Facility-specific O&M plans

To Use This Chapter:

1) After using **Chapters 1.0** and **2.0** to complete a stormwater management design for the project, fill out **Form O&M**.
2) Form O&M includes a blank section to insert a **site plan**, or attach a separate site plan sheet showing the location of the stormwater management facilities on the site, sources of stormwater runoff, and ultimate stormwater disposal point.
3) For **private** facilities: Record a copy of **Form O&M** and the **site plan** with the County Recorder or Clerk.
4) Submit a recorded copy of these sheets, along with the **facility-specific O&M plan** for each stormwater management facility used on-site, with the permit application. The O&M activities listed on the facility-specific O&M forms, which will be on file with the City, may later be revised with City approval.
5) For **public** facilities: Submit a copy of an O&M plan with the public works permit application. County recording of this plan is not necessary.

Note: Enforcement rules regarding the inspection, operations, and maintenance of stormwater management facilities can be found in the City of Grants Pass Development Code Article 1, Article 23, Article 24 and Article 28.

3.1 APPLICABILITY OF O&M REQUIREMENTS

The operations and maintenance (O&M) requirements in this chapter apply to:

- All stormwater management facilities and related facility components identified in **Chapter 2.0**.

  Exceptions: 1) Developments treating less than 500 square-feet of impervious surface with new trees do not need to submit or record O&M plans for the new trees used as simplified approaches.

  2) O&M plans do not need to be submitted for existing tree canopy.

- City personnel are responsible for the operations and maintenance of capital improvement projects. These CIP projects may or may not include requirements for maintenance in the contract specifications when contractors are hired to perform work.

This chapter provides a **facility-specific O&M plan** that identifies the O&M requirements for each type of facility included in this manual. If a stormwater facility that is not included in this manual is used (such as a manufactured stormwater treatment technology) it is still necessary to prepare and submit an O&M plan, along with facility-specific O&M activities that complies with the requirements of this chapter.

3.2 O&M SUBMITTAL REQUIREMENTS

3.2.1 Requirements for Privately Maintained Facilities

Form O&M: Operations & Maintenance Plan (see page 3-7) identifies the owner's name, address, and phone number, the site address, financial method used to cover future operation and maintenance, and parties responsible for inspecting and maintaining the facility. It also provides a space to insert a site plan to identify the location of the facility on the site, sources of runoff entering the facility, and ultimate stormwater disposal point. This form must be included with every private stormwater management facility permit application, and must be recorded with the county before permit issuance.

Facility-specific O&M plans (see page 3-10 through 3-25) identify the specific O&M activities that are required for each type of stormwater management facility. The appropriate plans must be attached to **Form O&M** and submitted as part of the stormwater management facility permit application. The facility-specific O&M plans do not have to be recorded with the county. This allows the

future stormwater management facility owner to revise O&M activities, with City approval, without the need to re-record the O&M plan with the county.

The facility-specific O&M activities for private facilities may be modified any time after permit issuance. This is optional, and is intended to give the owner an opportunity to adjust maintenance needs according to site-specific history and conditions. Proposed modifications to the O&M plan must be submitted to the City for review and approval.

An **Inspection and Maintenance Log must** be kept by facility owners. In general, the log should note all inspection dates, the facility components that were inspected, and any maintenance or repairs made. The facility-specific O&M plans can serve as a checklist for what should be included in the log (e.g. the facility elements that need to be inspected, frequency of inspection, conditions that indicate maintenance is needed, etc.). See page 3-9 for an **inspection and maintenance log sample**.

3.2.2 Requirements for City-Maintained Facilities

The City shall require that a stormwater management facility that receives stormwater runoff from a public right-of-way shall be dedicated a public (City-maintained) facility unless the right-of-way is not part of the City's road maintenance system. Facilities that will become City-maintained must be constructed under a public works permit.

For facilities built under a public works permit a preliminary O&M plan shall be submitted before construction, as part of the applicant's public works permit application package. **Form O&M** and **facility-specific O&M plans** may be used to serve as the O&M plan. In addition, the applicant shall demonstrate on the public works plans that the City can achieve the specified O&M activities. This may involve the construction of maintenance access roads and the dedication of public access easements.

Contractors building facilities under a public works permit are responsible for maintaining all site stormwater management features, including their associated vegetative components, during a 2-year maintenance warranty period.

At the end of this period, the City requires a modified O&M plan for all site features, based on experience with the site over the 2 years**.** Final facility sign-off will not be given until the modified O&M plan has been submitted. Contractors working directly for the City shall follow the specifications in their contracts.

3.3 O&M PLAN ENFORCEMENT

City code Chapter 28.090 requires that all stormwater management facilities, constructed to comply with the requirements of this manual, must be properly operated and maintained for the life of the facility. City staff has the right and responsibility to inspect facilities to assure they are being properly operated and maintained. It is the intent of the City to use education and technical assistance to ensure the proper O&M of private facilities. Administrative rules and procedures regarding City inspection and enforcement activities for assurance of proper O&M can be found in the City of Grants Pass Development Code Article 1, Article 23, Article 24 and Article 28.

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FORM O&M: OPERATIONS & MAINTENANCE PLAN INSTRUCTIONS

The following are instructions to prepare and file Form O&M: Operations & Maintenance Plan for a stormwater management facility.

City of Grants Pass Code Section 28.090 states that "Maintenance plans for all stormwater treatment facilities installed to comply with this ordinance. The maintenance program shall be subject to a recorded agreement with the City that outlines the stormwater treatment facility responsibilities of property owners and the City."

Failure to properly operate or maintain the water quality or quantity control facility according to the operation and maintenance plan may result in a civil penalty, as specified in Article 1.060: Enforcement and Penalties.

A copy of the operation and maintenance plan shall be filed with the City. Completed O&M Plans shall be submitted to:

City of Grants Pass
101 NW "A" Street
Grants Pass, OR. 97526

The operation and maintenance plan and site plan shall be recorded and filed with Josephine County

Before recording the O&M plan, the applicant shall sign the form, and the signature shall be notarized. When completed accurately, this form meets the recording requirements in Josephine County. The notarized O&M plan may be submitted in person or mailed, along with payment of the applicable fees, to the City of Grants Pass.

County Clerk's Office Address

Josephine County Clerk
500 NW 6th Street
Grants Pass, OR. 97526

FORM O&M: OPERATIONS & MAINTENANCE PLAN

INSTRUCTIONS (PAGE 2)

1: Fill out Form O&M (Page 3-6)

Project building application number: City staff will insert this number.

Owner: Print the name of the property owner.

Phone no.: Print the area code and 7-digit phone number of the property owner.

Mailing address: Print the property owner's mailing address, including zip code. After the plan is recorded with the county recorder's office, a copy of the recorded O&M Plan will be mailed to this address. The City will also use this address if further correspondence is required.

Site address: Print the address of the property where the stormwater management facility is located.

Site legal description: Attach a copy of the property's legal description. Property legal descriptions may be obtained from deed or title companies.

Signature: Sign the O&M plan form under "filer" in the presence of a notary.

Site plan: Include a site plan showing the facility location (in relation to building structures or other permanent monuments on the site), the sources of runoff entering the stormwater facility, and where stormwater will be discharged to after leaving the facility. The site plan can be inserted on Form O&M or included as a separate sheet.

Description of the financial method used to cover future operations and maintenance:
Check the appropriate box.

Party (ies) responsible for maintenance:
Provide the name, address, and phone number (both daytime and after-hours numbers) for the person or company who shall be responsible for maintaining or directly supervising the maintenance of the stormwater facilities described in the O&M Plan.

Maintenance practices and schedule for the stormwater management facility:
Provide the date the O&M Plan was prepared, the date the plan was revised (if applicable), and the month and year of the stormwater management facility installation. Provide the name, firm (if applicable), and address of the person who prepared the O&M Plan.

STORMWATER MANAGEMENT FACILITY
FORM O&M: OPERATIONS & MAINTENANCE PLAN
REQUIRED IN ACCORDANCE WITH CITY CODE CHAPTER 24.347

Project Building Application No.	*For official county use only*
Owner's Name	
Phone No. (area code required) **(_____) _____ - _____**	
Mailing Address (RETURN ADDRESS FOR RECORDER**)**	
Site Address	
Site Legal Description	

BY SIGNING BELOW, filer accepts and agrees to the terms and conditions contained in this operations & maintenance plan and in any document executed by filer and recorded with it.

_____

Filer

NOTARIZATION: GIVEN under my hand and official seal

this _____ day of _____ , _____.

Notary Public in and for the State of Oregon:

My Appointment Expires on:

O&M PLAN REQUIRED INFORMATION:

1) Site Plan. Include a site plan showing the facility location (in relation to building structures or other permanent monuments on the site), sources of runoff entering the facility, and where stormwater will be discharged to after leaving the facility. **The stormwater management facility located on this site plan is a required condition of building permit approval for the identified property. The owner of the identified property is required to operate and maintain this facility in accordance with the O&M plan on file with the City of Grants Pass. The requirement to operate and maintain this facility in accordance with the on-file O&M plan is binding on all current and future owners of the property. The O&M plan may be modified under written consent of new owners with written approval by and re-filing with the City. The O&M plan for this facility is available at the City of Grants Pass, 101 NW A Street, Grants Pass, Oregon, between the hours of 8 a.m. and 5 p.m., Monday through Friday.**	**Site Plan (insert here or include separate sheet):**

2) Description of the financial method used to cover future operations and maintenance. ***Check One:***

❑ Homeowner Association ❑ Property Owner Account ❑ Other (d*escribe)*_____

3) Party (ies) responsible for maintenance (only if other than owner).

Daytime Phone No. (area code required)(_____) _____ - _____	Emergency/After-Hours Contact Phone No. (_____) _____ - _____
Maintenance Contact & Address	

4) Maintenance practices and schedule for the stormwater facility is included in the facility-specific O&M plan filed with the City of Grants Pass. The operation and maintenance practices are based on the publication date of the City of Grants Pass Stormwater Management Manual.

Preparation Date ___ / ____ / _____	Revision Date ____ / ____ / _____	Estimated Date of Installation *(month/year)* ___ / ___

Prepared By_____

STORMWATER MANAGEMENT FACILITY
FORM O&M: OPERATIONS & MAINTENANCE PLAN
REQUIRED IN ACCORDANCE WITH CITY CODE CHAPTER 24.347

Project Building Application No.

For official county use only

Owner's Name John Doe

Phone No. (area code required) (_503_) _555_ - _5555__

Mailing Address (RETURN ADDRESS FOR RECORDER)
XXX NW XXX Street, Grants Pass, OR XXXXX

Site Address
XXX NW XXX Street, Grants Pass, OR XXXXX

Site Legal Description
Section XX, Township XX, Range XX, Tax Lot XX

BY SIGNING BELOW, filer accepts and agrees to the terms and conditions contained in this operations & maintenance plan and in any document executed by filer and recorded with it.

_____
Filer

NOTARIZATION: GIVEN under my hand and official seal
this _____ day of _____ , _____.

Notary Public in and for the State of Oregon:

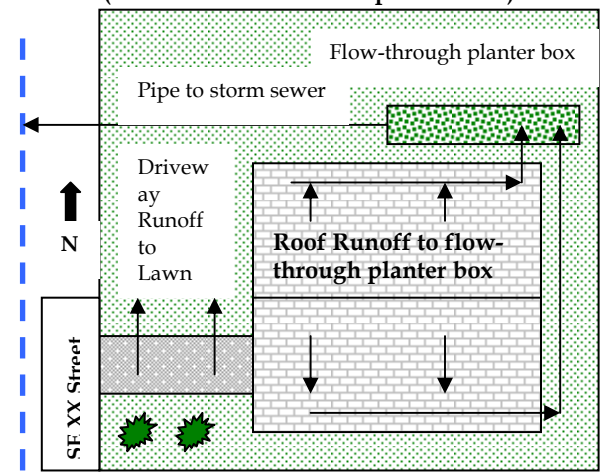
My Appointment Expires on:

O&M PLAN REQUIRED INFORMATION:

1) Site Plan. Include a site plan showing the facility location (in relation to building structures or other permanent monuments on the site), sources of runoff entering the facility, and where stormwater will be discharged to after leaving the facility.

The stormwater management facility located on this site plan is a required condition of building permit approval for the identified property. The owner of the identified property is required to operate and maintain this facility in accordance with the O&M plan on file with the City of Grants Pass. The requirement to operate and maintain this facility in accordance with the on-file O&M plan is binding on all current and future owners of the property. The O&M plan may be modified under written consent of new owners with written approval by and re-filing with the City. The O&M plan for this facility is available at 1120 SW 5th Avenue, Room 1000, Grants Pass, Oregon, between the hours of 8 a.m. and 5 p.m., Monday through Friday.

Site Plan (insert here or include separate sheet):



2) Description of the financial method used to cover future operations and maintenance. ***Check One:***

❑ Homeowner Association **X** Property Owner Account ❑ Other *(describe)*_____

3) Party (ies) responsible for maintenance (only if other than owner). **Owner Responsible**

Daytime Phone No. (area code required) **(541) xxx--xxxx** | Emergency/After-Hours Contact Phone No. **(541) xxx-xxxx**

Maintenance Contact & Address **Garden Guy Landscaping XXX NE XX Street Grants Pass, OR 97XXX**

4) Maintenance practices and schedule for the stormwater facility is included in the facility-specific O&M plan filed with the Bureau of Environmental Services, City of Grants Pass. The operation and maintenance practices are based on the publication date of the City of Grants Pass's Stormwater Management Manual.

Preparation Date **XX/ XX /200X** | Revision Date ____ / ____ / _____ | Estimated Date of Installation *(month/year)* **XX /XXXX**

Prepared By **John Doe**

STORMWATER MANAGEMENT FACILITY
INSPECTION & MAINTENANCE LOG (SAMPLE)

Property Address:

Inspection Date:

Inspection Time:

Inspected By:

Approximate Date/Time of Last Rainfall:

Type of Stormwater Management Facility:

Location of Facility on Site (In relation to buildings or other permanent structures):

Water levels and observations (Oil sheen, smell, turbidity, etc.):

Sediment accumulation & record of sediment removal:

Condition of vegetation (Height, survival rates, invasive species present, etc.) & record of replacement and management (mowing, weeding, etc.):

Condition of physical properties such as inlets, outlets, piping, fences, irrigation facilities, and side slopes. Record damaged items and replacement activities:

Presence of insects or vectors. Record control activities:

Identify safety hazards present. Record resolution activities:

FACILITY-SPECIFIC OPERATIONS AND MAINTENANCE PLANS

FACILITY **PAGE**

Pervious Pavement
Operations & Maintenance Plan

Pervious pavement is a permeable pavement surface with an underlying stone reservoir that temporarily stores surface runoff before infiltrating into the subsoil or being collected in underlying drain pipes and being discharged off-site. There are many types of pervious pavement including plastic rings planted with grass, stone or concrete blocks with pore spaces backfilled with gravel or sand, porous asphalt, and porous concrete. Pervious pavement accepts only precipitation, not stormwater runoff. All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

Surface: In most pervious pavement design, the pavement itself acts as pretreatment to the stone reservoir below. The surface shall be kept clean and free of leaves, debris, and sediment. The surface shall not be overlaid with an impermeable paving surface

- Regular sweeping shall be implemented for porous asphalt or concrete systems.

Overflows or Emergency Spillways are used in the event that the facility's infiltration capacity is exceeded. Overflow devices shall be inspected for obstructions or debris, which shall be removed upon discovery Overflow or emergency spillways shall be capable of transporting high flows of stormwater to an approved stormwater receiving system.

- Sources of erosion damage shall be identified and controlled when native soil is exposed near the overflow structure.

Vegetation (where applicable) shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion. Vegetation, such as trees and shrubs, should not be located in or around the pervious pavement because roots from trees can penetrate the pavement, and leaves from deciduous trees and shrubs can increase the risk of clogging the surface.

- Vegetation and large shrubs/trees that limit access or interfere with porous pavement operation shall be pruned.
- Fallen leaves and debris from deciduous plant foliage shall be raked and removed.
- Poisonous, nuisance, dead or odor producing vegetation shall be removed immediately.
- Grass shall be mowed to less than four inches and grass clippings shall be bagged and removed.
- Irrigation shall be provided as needed.

Source Control measures prevent pollutants from mixing with stormwater. Typical non-structural control measures include raking and removing leaves, street sweeping, vacuum sweeping, limited and controlled application of pesticides and fertilizers, and other good house keeping practices.

Spill Prevention measures shall be exercised when handling substances that can contaminate stormwater. A spill prevention plan shall be implemented at all non-residential sites and in areas where there is likelihood of spills from hazardous materials. However, virtually all sites, including residential and commercial, present potential danger from spills. All homes contain a wide variety of toxic materials including gasoline for lawn mowers, antifreeze for cars, solvents, pesticides, and cleaning aids that can adversely affect storm water if spilled. It is important to exercise caution when handling substances that can contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.

Training and/or written guidance information for operating and maintaining pervious pavement shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.

Access to the pervious pavement shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.
Obstacles preventing maintenance personnel and/or equipment access to the porous pavement shall be removed.
Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.

Insects & Rodents shall not be harbored at the pervious pavement. Pest control measures shall be taken when insects/rodents are found to be present.

- Standing water creating an environment for development of insect larvae shall be eliminated.
- If sprays are considered, then a mosquito larvicide, such as Bacillus thurengensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
- Holes in the ground located in and around the pervious pavement shall be filled and compacted.

If used at this site, the following will be applicable:

Signage may serve to educate people about the importance or function of the site's stormwater protection measures. It may also discourage behaviors that adversely affect stormwater protection measures. For example, if debris is a problem, a sign reminding people not to litter may partially solve the problem. Broken or defaced signs shall be replaced/repaired.

Vegetated, Grassy, and Street Swales
Operations & Maintenance Plan

Swales are planted or grassed open channels that trap pollutants by filtering and slowing flows, allowing particles to settle out. The swale should drain within 48 hours of a storm event. All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

Swale Inlet (such as curb cuts or pipes) shall maintain a calm flow of water entering the swale*.*

- Source of erosion shall be identified and controlled when native soil is exposed or erosion channels are forming.
- Sediment accumulation shall be hand-removed with minimum damage to vegetation using proper erosion control measures. Sediment shall be removed if it is more than 4" thick or so thick as to damage or kill vegetation.
- Inlet shall be cleared when conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
- Rock splash pads shall be replenished to prevent erosion.

Side Slopes shall be maintained to prevent erosion that introduces sediment into the swale.

- Slopes shall be stabilized and planted using appropriate erosion control measures when native soil is exposed or erosion channels are forming.

Swale Media shall allow stormwater to percolate uniformly through the landscape swale. If the swale does not drain within 48 hours, it shall be tilled and replanted according to design specifications.

- Annual or semi-annual tilling shall be implemented if compaction or clogging continues.
- Debris in quantities that inhibit operation shall be removed routinely (e.g., no less than quarterly), or upon discovery.

Swale Outlet shall maintain sheet flow of water exiting swale unless a collection drain is used. Source of erosion damage shall be identified and controlled when native soil is exposed or erosion channels are forming.

- Outlets such as drains and overland flow paths shall be cleared when 50% of the conveyance capacity is plugged.
- Sources of sediment and debris shall be identified and corrected.

Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion. Mulch shall be replenished as needed to ensure survival of vegetation.

- Vegetation, large shrubs or trees that interfere with landscape swale operation shall be pruned.
- Fallen leaves and debris from deciduous plant foliage shall be removed.
- Grassy swales shall be mowed to keep grass 4” to 9” in height.
- Nuisance and prohibited vegetation from the Grants Pass Plant List (such as blackberries and English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Dead vegetation and woody material shall be removed to maintain less than 10% of area coverage or when swale function is impaired. Vegetation shall be replaced within 3 months, or immediately if required to maintain cover density and control erosion where soils are exposed.

Spill Prevention measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.

Training and/or written guidance information for operating and maintaining swales shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.

Access to the swale shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.

- Obstacles preventing maintenance personnel and/or equipment access to the swale shall be removed.
- Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.

Insects & Rodents shall not be harbored in the swale. Pest control measures shall be taken when insects/rodents are found to be present.

- If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
- Holes in the ground located in and around the swale shall be filled.

If used at this site, the following will be applicable:

Check Dams shall control and distribute flow.

- Causes for altered water flow shall be identified, and obstructions cleared upon discovery.
- Causes for channelization shall be identified and repaired.

Vegetated Filters

Operations & Maintenance Plan

Vegetated filters are gently sloped vegetated areas that stormwater runoff is directed to flow and filter through. Stormwater enters the filter as sheet flow from an impervious surface or is converted to sheet flow using a flow spreader. Flow control is achieved using the relatively large surface area and check dams. Pollutants are removed through infiltration and sedimentation. The vegetative filter should drain within 48 hours of storm event. All facility components and vegetation shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

Flow Spreader shall allow runoff to enter the vegetative filter as predominantly sheet flow.

- Source of erosion damage shall be identified and controlled when native soil is exposed or erosion channels are forming.
- Sediment build-up near or exceeding 2" in depth shall be removed.

Filter Inlet shall assure unrestricted stormwater flow to the vegetative filter.

- Sources of erosion shall be identified and controlled when native soil is exposed or erosion channels are present.
- Sediment accumulation shall be hand-removed with minimum damage to vegetation using proper erosion control measures. Sediment shall be removed if it is more than 4 inches thick or so thick as to damage or kill vegetation.
- Inlet shall be cleared when conveyance capacity is plugged.
- Rock splash pads shall be replenished to prevent erosion.

Filter Media shall allow stormwater to percolate uniformly through the vegetative filter.

- If the vegetative filter does not drain within 48 hours, it shall be regraded and replanted according to design specifications. Established trees shall not be removed or harmed in this process.
- Debris in quantities more than 2" deep or sufficient to inhibit operation shall be removed routinely (e.g., no less than quarterly), or upon discovery.

Check Dams shall direct and control flow.

- Causes for altered water flow and channelization shall be identified, and obstructions cleared upon discovery.
- Cracks, rot, and structural damage shall be repaired.

Filter Outlet shall allow water to exit the vegetative filter as sheet flow, unless a collection drainpipe is used.

- Sources of erosion damage shall be identified and controlled when native soil is exposed or erosion channels are deeper than 2 inches.
- Outlet shall be cleared when 50% of the conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.

Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion.

- Fallen leaves and debris from deciduous plant foliage shall be raked and removed.
- Nuisance and prohibited vegetation from the Grants Pass Plant List (such as blackberries and English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Dead vegetation shall be removed to maintain less than 10% of area coverage or when vegetative filter function is impaired. Vegetation shall be replaced immediately to control erosion where soils are exposed and within 3 months to maintain cover density.

Spill Prevention measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.

Training and/or written guidance information for operating and maintaining vegetated filters shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.

Access to the vegetative filter shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Obstacles preventing maintenance personnel and/or equipment access to the facility shall be removed. Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.

Insects & Rodents shall not be harbored in the vegetated filter. Pest control measures shall be taken when insects/rodents are found to be present.

- If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
- Holes in the ground located in and around the vegetated filter shall be filled.

Infiltration and Flow-Through Planters

Operations & Maintenance Plan

Planters are designed to allow runoff to filter through layers of topsoil (thus capturing pollutants) and then either infiltrate into the native soils (infiltration planter) or be collected in a pipe to be discharged off-site (flow-through planter). The planter is sized to accept runoff and temporarily store the water in a reservoir on top of the soil. The flow-through planter is designed with an impervious bottom or is placed on an impervious surface. Water should drain through the planter within 3-4 hours after a storm event. All facility components and vegetation shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

Downspout from rooftop or sheet flow from paving allows unimpeded stormwater flow to the planter.

- Debris shall be removed routinely (e.g., no less than every 6 months) and upon discovery.
- Damaged pipe shall be repaired upon discovery.

Splash Blocks prevent splashing against adjacent structures and convey water without disrupting media.

- Any deficiencies in structure such as cracking, rotting, and failure shall be repaired.

Planter Reservoir receives and detains storm water prior to infiltration. Water should drain from reservoir within 3-4 hours of storm event.

- Sources of clogging shall be identified and corrected.
- Topsoil may need to be amended with sand or replaced all together.

Filter Media consisting of sand, gravel, and topsoil shall allow stormwater to percolate uniformly through the planter. The planter shall be excavated and cleaned, and gravel or soil shall be replaced to correct low infiltration rates.

- Holes that are not consistent with the design and allow water to flow directly through the planter to the ground shall be plugged.
- Sediment accumulation shall be hand removed with minimum damage to vegetation using proper erosion control measures. Sediment shall be removed if it is more than 4 inches thick or so thick as to damage or kill vegetation.
- Litter and debris shall be removed routinely (e.g., no less than quarterly) and upon discovery.

Planter shall contain filter media and vegetation.

- Structural deficiencies in the planter including rot, cracks, and failure shall be repaired.

Overflow Pipe safely conveys flow exceeding reservoir capacity to an approved stormwater receiving system.

- Overflow pipe shall be cleared of sediment and debris when 50% of the conveyance capacity is plugged.
- Damaged pipe shall be repaired or replaced upon discovery.

Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion.

- Mulch shall be replenished at least annually.
- Vegetation, large shrubs or trees that limit access or interfere with planter operation shall be pruned or removed.
- Fallen leaves and debris from deciduous plant foliage shall be raked and removed.
- Nuisance or prohibited vegetation from the Grants Pass Plant List shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Dead vegetation shall be removed to maintain less than 10% of area coverage or when planter function is impaired. Vegetation shall be replaced within a specific timeframe, e.g., 3 months, or immediately if required to maintain cover density and control erosion where soils are exposed.

Spill Prevention measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.

Training and/or written guidance information for operating and maintaining stormwater planters shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.

Access to the stormwater planter shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.

- Obstacles preventing maintenance personnel and/or equipment access to the stormwater planter shall be removed.
- Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.

Insects & Rodents shall not be harbored in the stormwater planter.
Pest control measures shall be taken when insects/rodents are found to be present.
If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
Holes in the ground located in and around the stormwater planter shall be filled and compacted.

Vegetated Infiltration Basins
Operations & Maintenance Plan

A **vegetated Infiltration Basin** is a vegetated depression created by excavation, berms, or small dams to provide for short-term ponding of surface water until it percolates into the soil. The basin shall infiltrate stormwater within 24 hours. All facility components and vegetation shall be inspected for proper operations and structural stability, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

Basin Inlet shall assure unrestricted stormwater flow to the vegetated basin.

- Sources of erosion shall be identified and controlled when native soil is exposed or erosion channels are present.
- Inlet shall be cleared when conveyance capacity is plugged.
- Rock splash pads shall be replenished to prevent erosion.

Embankment, Dikes, Berms & Side Slopes retain water in the infiltration basin.

- Structural deficiencies shall be corrected upon discovery:
- Slopes shall be stabilized using appropriate erosion control measures when soil is exposed/ flow channels are forming.
- Sources of erosion damage shall be identified and controlled.

Overflow or Emergency Spillway conveys flow exceeding reservoir capacity to an approved stormwater receiving system.

- Overflow shall be cleared when 25% of the conveyance capacity is plugged.
- Sources of erosion damage shall be identified and controlled when soil is exposed.
- Rocks or other armament shall be replaced when only one layer of rock exists.

Filter Media shall allow stormwater to percolate uniformly through the infiltration basin. If water remains 36-48 hours after storm, sources of possible clogging shall be identified and corrected.

- Basin shall be raked and, if necessary, soil shall be excavated, and cleaned or replaced.

Sediment/ Debris Management shall prevent loss of infiltration basin volume caused by sedimentation. Gauges located at the opposite ends of the basin shall be maintained to monitor sedimentation.

- Sediment and debris exceeding 4" in depth shall be removed every 2-5 years or sooner if performance is affected.
- Restricted sources of sediment and debris, such as discarded lawn clippings, shall be identified and prevented.

Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion.

- Mulch shall be replenished as needed to ensure healthy plant growth.
- Vegetation, large shrubs or trees that limit access or interfere with basin operation shall be pruned or removed.
- Grass shall be mowed to 4"-9" high and grass clippings shall be removed no less than 2 times per year.
- Fallen leaves and debris from deciduous plant foliage shall be raked and removed.
- Nuisance or prohibited vegetation from the Grants Pass Plant List (such as blackberries or English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed.
- Dead vegetation shall be removed to maintain less than 10% of area coverage or when infiltration basin function is impaired. Vegetation shall be replaced within 3 months, or immediately if required to control erosion.

Spill Prevention measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.

Training and/or written guidance information for operating and maintaining vegetated infiltration basins shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.

Access to the infiltration basin shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.

- Obstacles preventing maintenance personnel and/or equipment access to the infiltration basin shall be removed.
- Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.

Insects & Rodents shall not be harbored in the infiltration basin. Pest control measures shall be taken when insects/rodents are found to be present.

- If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
- Holes in the ground located in and around the infiltration basin shall be filled.

If used at this site, the following will be applicable:

Fences shall be maintained to preserve their functionality and appearance.

- Collapsed fences shall be restored to an upright position, jdamaged fences shall be repaired or replaced.

Soakage Trenches

Operations & Maintenance Plan

Soakage Trenches consist of drain rock and sand, and receive stormwater from roof downspouts and/or area drains. There are various components within the system - piping, silt basin and the trench itself. The **Conveyance Piping** consists of an inlet pipe (downspout or area drain), an outlet pipe located between the silt basin and the soakage trench, and a perforated pipe, located on top of the aggregate bed of the soakage trench. The **Silt Basin** is a structure receiving runoff from an inlet pipe and conveying it to the soakage trench. The silt basin serves as the pre-treatment system for the soakage trench, removing sediments and other debris that can impact its proper functioning. All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first two years from the date of installation, then two times per year afterwards, or within 48 hours after each major storm. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

Soakage trench infiltration: If water is noticed on top of the trench within 48 hours of a major storm, the soakage trench may be clogged.

- Check for debris/sediment accumulation, rake and remove and evaluate upland causes (erosion, surface or roof debris, etc
- Assess the condition of the aggregate and the filter fabric in the trench. If there is sediment in the aggregate, excavate and replace.
- If there is a tear in the filter fabric, repair or replace.

Conveyance Piping: If water ponds over the trench for more than 48 hours after a major storm and no other cause if identified, it may be necessary to remove the filter fabric to determine if the perforated pipe is clogged with sediment or debris.

- Any debris or algae growth located on top of the soakage trench should be removed and disposed of properly.
- If the piping has settled more than 1-inch, add fill material. If there are cracks or releases, replace or repair the pipe. If there are signs of erosion around the pipe, this may be an indication of water seeping due to a crack or break.

Silt Basin: If water remains in the soakage trench for 36-48 hours after storm, check for sediment accumulation in the silt basin

- If less than 50% capacity remains in the basin or 6" of sediment has accumulated, remove and dispose the sediment.

Spill Prevention*:* Virtually all sites, including residential and commercial, present dangers from spills. All homes contain a wide variety of toxic materials including gasoline for lawn mowers, antifreeze for cars, nail polish remover, pesticides, and cleaning aids that can adversely affect groundwater if spilled. It is important to exercise caution when handling substances that can contaminate stormwater.

- Activities that pose the chance of hazardous material spills shall not take place near soakage trenches.

A **Shut-Off Valve or Flow-Blocking Mechanism** may have been required with the construction of the soakage trench to temporarily prevent stormwater from flowing into it, in the event of an accidental toxic material spill. This may also involve mats kept on-site that can be used to cover inlet drains in parking lots. The shut-off valve shall remain in good working order, or if mats or other flow-blocking mechanisms are used, they shall be kept in stock on-site.

Training and/or written guidance information for operating and maintaining soakage trenches shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.

Access to the soakage trench is required for efficient maintenance. Egress and ingress routes will be maintained to design standards at inspections.

Insects & Rodents shall not be harbored in the soakage trench. Pest control measures shall be taken when insects/rodents are found to be present.

- If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
- Holes in the ground located in and around the soakage trench shall be filled.

Wet, Extended Wet Detention, and Dry Detention Ponds

Operations & Maintenance Plan

Wet Ponds are constructed ponds with a permanent pool of water. Pollutants are removed from stormwater through gravitational settling and biologic processes. **Extended Wet Ponds** are constructed ponds with a permanent pool of water and open storage space above for short-term detention of large storm events. Pollutants are removed from stormwater through gravitational settling and biologic processes. **Dry Detention Ponds** are constructed ponds with temporary storage for the detention of large storm events. The stormwater is stored and released slowly over a matter of hours. All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, and 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

Pond Inlet shall assure unrestricted stormwater flow to the wet pond.

- Inlet pipe shall be cleared when conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
- Determine if pipe is in good condition:
  - If more than 1 inch of settlement, add fill material and compact soils.
  - If alignment is faulty, correct alignment.
  - If cracks or openings exist indicated by evidence of erosion at leaks, repair or replace pipe as needed.

Forebay traps coarse sediments, reduces incoming velocity, and distributes runoff evenly over the wet pond. A minimum 1-foot freeboard shall be maintained.

- Sediment buildup exceeding 50% of the facility capacity shall be removed every 2-5 years, or sooner if performance is being affected.

Embankment, Dikes, Berms & Side Slopes retain water in the wet pond.

- Slopes shall be stabilized using appropriate erosion control measures when native soil is exposed or erosion channels are forming.
- Structural deficiencies shall be corrected upon discovery:
  - If cracks exist, repair or replace structure.
  - If erosion channels deeper than 2 inches exist, stabilize surface. Sources of erosion damage shall be identified and controlled.

Control Devices (e.g., weirs, baffles, etc.) shall direct and reduce flow velocity. Structural deficiencies shall be corrected upon discovery:

- If cracks exist, repair or replace structure.

Overflow Structure conveys flow exceeding reservoir capacity to an approved stormwater receiving system.

- Overflow structure shall be cleared when 50% of the conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
- Sources of erosion damage shall be identified and controlled when native soil is exposed at the top of overflow structure or erosion channels are forming.
- Rocks or other armoring shall be replaced when only one layer of rock exists above native soil.

Sediment & Debris Management shall prevent loss of wet pond volume caused by sedimentation.

- Wet ponds shall be dredged when 1 foot of sediment accumulates in the pond.
- Gauges located at the opposite ends of the wet pond shall be maintained to monitor sedimentation. Gauges shall be checked 2 times per year.
- Sources of restricted sediment or debris, such as discarded lawn clippings, shall be identified and prevented.
- Debris in quantities sufficient to inhibit operation shall be removed routinely, e.g. no less than quarterly, or upon discovery.

Wet, Extended Wet Detention, and Dry Detention Ponds Operations & Maintenance Plan
Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion and minimizing solar exposure of open water areas. • Mulch shall be replenished at least annually. • Vegetation, large shrubs or trees that limit access or interfere with wet pond operation shall be pruned or removed. • Grass (where applicable) shall be mowed to 4"-9" high and grass clippings shall be removed. • Fallen leaves and debris from deciduous plant foliage shall be raked and removed. • Nuisance or prohibited vegetation from the Grants Pass Plant List (such as blackberries or English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced. • Dead vegetation shall be removed to maintain less than 10% of area coverage or when wet pond function is impaired. Vegetation shall be replaced within 3 months, or immediately if required to maintain cover density and control erosion where soils are exposed. • Vegetation producing foul odors shall be eliminated.
Spill Prevention measures shall be exercised when handling substances that can contaminate stormwater Releases of pollutants shall be corrected as soon as identified.
Training and/or written guidance information for operating and maintaining ponds shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.
Access to the wet pond shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable. • Obstacles preventing maintenance personnel and/or equipment access to the wet pond shall be removed. • Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.
Insects & Rodents shall not be harbored in the pond. Pest control measures shall be taken when insects/rodents are found to be present. • If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor. • Holes in the ground located in and around the pond shall be filled.
If used at this site, the following will be applicable:
Signage shall clearly convey information. • Broken or defaced signs shall be replaced or repaired.
Fences shall be maintained to preserve their functionality and appearance. • Collapsed fences shall be restored to an upright position. • Jagged edges and damaged fences and shall be repaired or replaced.

Constructed Treatment Wetlands

Operations & Maintenance Plan

Constructed Treatment Wetlands remove pollutants through several processes: sedimentation, filtration, and biological processes. All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, and 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

Wetland Inlet shall assure unrestricted stormwater flow to the wetland.

- Inlet pipe shall be cleared when conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
- Determine if pipe is in good condition:
  - If more than 1 inch of settlement, add fill material and compact soils.
  - If alignment is faulty, correct alignment.
  - If cracks or openings exist indicated by evidence of erosion at leaks, repair or replace pipe as needed.

Forebay traps coarse sediments, reduces incoming velocity, and distributes runoff evenly over the wetland. A minimum 1-foot freeboard shall be maintained.

- Sediment buildup exceeding 50% of the facility capacity shall be removed every 2-5 years, or sooner if performance is being affected.

Embankment, Dikes, Berms & Side Slopes retain water in the wetland.

- Slopes shall be stabilized using appropriate erosion control measures when native soil is exposed or erosion channels are forming.
- Structural deficiencies shall be corrected upon discovery:
  - If cracks exist, repair or replace structure.
  - If erosion channels deeper than 2 inches exist, stabilize surface. Sources of erosion damage shall be identified and controlled.

Control Devices (e.g., weirs, baffles, etc.) shall direct and reduce flow velocity.

- Structural deficiencies shall be corrected upon discovery:
- If cracks exist, repair or replace structure.

Overflow Structure conveys flow exceeding reservoir capacity to an approved stormwater receiving system.

- Overflow structure shall be cleared when 50% of the conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
- Sources of erosion damage shall be identified and controlled when native soil is exposed at the top of overflow structure or erosion channels are forming.
- Rocks or other armament shall be replaced when only one layer of rock exists above native soil.

Sediment & Debris Management shall prevent loss of wetland volume caused by sedimentation.

- Wetlands shall be dredged when 1 foot of sediment accumulates.
- Gauges located at the opposite ends of the wetland shall be maintained to monitor sedimentation. Gauges shall be checked 2 times per year.
- Sources of restricted sediment or debris, such as discarded lawn clippings, shall be identified and prevented.
- Debris in quantities sufficient to inhibit operation shall be removed routinely, e.g. no less than quarterly, or upon discovery.

Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion and minimizing solar exposure of open water areas.

- Mulch shall be replenished when needed.
- Vegetation, large shrubs or trees that limit access or interfere with wetland operation shall be pruned.
- Fallen leaves and debris from deciduous plant foliage shall be raked and removed.
- Nuisance or prohibited vegetation from the Grants Pass Plant List (such as blackberries or English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Dead vegetation shall be removed to maintain less than 10% of area coverage or when wetland function is impaired. Vegetation shall be replaced within 3 months, or immediately if required to maintain cover density and control erosion where soils are exposed.
- Vegetation producing foul odors shall be eliminated.

Constructed Treatment Wetlands Operations & Maintenance Plan
Spill Prevention measures shall be exercised when handling substances that can contaminate stormwater Releases of pollutants shall be corrected as soon as identified.
Training and/or written guidance information for operating and maintaining treatment wetlands shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.
Access to the wetland shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable. • Obstacles preventing maintenance personnel and/or equipment access to the wetland shall be removed. • Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.
Insects & Rodents shall not be harbored in the constructed treatment wetland. Pest control measures shall be taken when insects/rodents are found to be present. • If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor. • Holes in the ground located in and around the constructed treatment wetland shall be filled.
If used at this site, the following will be applicable:
Signage shall clearly convey information. • Broken or defaced signs shall be replaced or repaired.
Fences shall be maintained to preserve their functionality and appearance. • Collapsed fences shall be restored to an upright position. • Jagged edges and damaged fences and shall be repaired or replaced.

Underground Detention Tanks, Vaults, and Pipes

Operations & Maintenance Plan

Underground detention tanks, vaults, and pipes are designed to fill with stormwater during large storm events, slowly releasing it over a number of hours. There are numerous components to each system. **Drain Inlet Pipes** convey stormwater into the detention facility. The **detention Chamber** is the structure in which stormwater accumulates during a storm event. **Orifice Structure/ Outlet Drain Pipe** restricts the flow out of the detention chamber, allowing it to fill up and slowly drain out. The orifice structure is located at the downstream end of the detention chamber. Underground facilities shall be inspected quarterly and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

Drain Inlet Pipes shall be inspected for clogging or leaks where it enters the vault or basin during every inspection and cleanout.

- Debris/sediment that is found to clog the inlet shall be removed, tested, and disposed of in accordance with applicable federal and state requirements.

Detention Chamber shall be inspected for cracks or damage during each inspection.

- The detention chamber shall be cleaned out yearly or after an inch of sediment has accumulated. If there is a valve on the outlet pipe it shall be closed otherwise the outlet shall be plugged prior to cleanout. Grit and sediment that has settled to the bottom of the chamber shall be removed during each cleaning.
- Water and sediment in the detention chamber shall be removed, tested, and disposed of in accordance with regulations.
- Cleaning shall be done without use of detergents or surfactants. A pressure washer may be used if necessary.

Orifice Structure/ Outlet Drain Pipe shall be inspected for clogging during unit inspections/cleanouts.

- Debris/sediment that is found to clog the inlet shall be removed, tested, and disposed of in accordance with applicable federal and state requirements.

Vegetation such as trees should not be located in or around the detention facility because roots from trees can penetrate the unit body, and leaves from deciduous trees and shrubs can increase the risk of clogging the intake pipe.

- Large shrubs or trees that are likely to interfere with detention facility operation shall be identified at each inspection then removed.

Source Control measures typically include structural and non-structural controls. Non-structural controls can include street sweeping and other good house keeping practices. It is often easier to prevent pollutants from entering stormwater than to remove them.

- Source control measures shall be inspected and maintained (where applicable).

Spill Prevention procedures require high-risk site users to reduce the risk of spills. However, virtually all sites, including residential and commercial, present dangers from spills. Homes contain a wide variety of toxic materials including gasoline for lawn mowers, antifreeze for cars, nail polish remover, pesticides, and cleaning aids that can adversely affect storm water if spilled. It is important for everyone to exercise caution when handling substances that can contaminate stormwater. Spill prevention procedures shall be implemented in areas where there is likelihood of spills from hazardous materials.

Training and/or written guidance information for operating and maintaining detention facilities shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.

Access to the detention facility is required for efficient maintenance.
Egress and ingress routes shall be open and maintained to design standards.

Signage may serve to educate people about the importance or function of the site's stormwater protection measures. Signs may also discourage behavior that adversely impacts the stormwater protection measures and encourages behavior that enhances or preserves stormwater quality. If debris is a problem, a sign reminding people not to litter may partially solve the problem.
Signage (where applicable) will be maintained and repaired as needed during or shortly after inspections.

Insects & Rodents shall not be harbored in the detention facility. Pest control measures shall be taken when insects/rodents are found to be present.

- If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
- Holes in the ground located in and around the detention facility shall be filled.

Spill Control Manholes

Operations & Maintenance Plan

Spill Control Manholes operate using the principal that oil and water are immiscible (do not mix) and have different densities. Oil, being less dense than water, floats to the surface. The spill control manhole shall be inspected and cleaned quarterly. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

Stormwater Drain Inlet Pipe shall be inspected for clogging or leaks where it enters the manhole during every inspection and cleanout. Debris/sediment that is found to clog the inlet shall be removed, tested, and disposed of in accordance with applicable federal and state requirements.

Manhole Chamber shall be inspected for cracks or damage during each inspection.

- The manhole shall be cleaned out quarterly. Cleanout shall be done in a manner to minimize the amount of trapped oil entering the outlet pipe. If there is a valve on the outlet pipe it shall be closed otherwise the outlet will be plugged prior to cleanout.
- Water and oil shall be removed, tested, and disposed of in accordance with regulations. Grit and sediment that has settled to the bottom of the chamber shall be removed during each cleaning
- Cleaning shall be done without use of detergents or surfactants. A pressure washer may be used if necessary.

Absorbent Pillows and Pads (where applicable) absorb oil from the separation chamber.

- Replacement shall occur at least twice a year, in the spring and fall, or as necessary to retain oil-absorbing function.

Stormwater Drain Outlet Pipe shall be inspected for clogging or leaks where it exits the manhole. Particular attention shall be paid to ensure that the joint where the tee joins the outlet pipe is watertight.

- Debris/sediment that is found to clog the outlet shall be removed, tested, and disposed of in accordance with applicable federal and state requirements.

Vegetation such as trees should not be located in or around the spill control manhole because roots can penetrate the unit body, and leaves from deciduous trees and shrubs can increase the risk of clogging.

- Large shrubs or trees that are likely to interfere with manhole operation shall be identified at each inspection and removed.

Source Control measures typically include structural and non-structural controls. Non-structural controls can include street sweeping and other good house keeping practices.

- Source control measures shall be inspected and maintained.

Spill Prevention procedures require high-risk site users to reduce the risk of spills. However, virtually all sites, including residential and commercial, present dangers from spills. Homes contain a wide variety of toxic materials including gasoline for lawn mowers, antifreeze for cars, nail polish remover, pesticides, and cleaning aids that can adversely affect storm water if spilled. It is important to exercise caution when handling substances that can contaminate stormwater.
Spill prevention procedures shall be implemented in areas where there is likelihood of spills from hazardous materials.

Training and/or written guidance information for operating and maintaining spill control manholes shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.

Access to the spill control manhole is required for efficient maintenance. Egress and ingress routes shall be open and maintained to design standards.

Insects & Rodents shall not be harbored in the spill control manhole. Pest control measures shall be taken when insects/rodents are found to be present.

- If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
- Holes in the ground located in and around the manhole shall be filled.

Signage may serve to educate people about the importance or function of the site's stormwater protection measures. Signage (where applicable) shall be maintained and repaired as needed during or shortly after inspections.

New Evergreen and Deciduous Trees Operations & Maintenance Plan
Trees intercept rainfall and therefore provide a level of pollution reduction and flow control. They also provide shade, helping to cool stormwater runoff. Trees used to meet stormwater management requirements shall be kept on a site and maintained properly to ensure continued stormwater benefits. Trees shall be inspected 2 times a year and within 48 hours of a major wind or storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:
Leaves and Debris from the tree shall be regularly raked and disposed of. • Fallen leaves and debris from deciduous plant foliage shall be raked and removed. • Poisonous and nuisance vegetation around the tree shall be removed when discovered. • Dead vegetation shall be pruned from the tree on a regular basis.
Irrigation shall be implemented during the establishment period to ensure tree survival. Hand watering is preferred, but a drip-irrigation system may be used.
Protection of the tree trunk and roots shall ensure tree survival. Care should be taken when digging near tree roots.
Replacement of dead trees shall be with a comparable species if it dies or must be removed for any another reason. The replacement tree shall be a minimum of 6' tall and 1.5 caliper inches.
Insects & Rodents shall not be harbored in or around the trees. Pest control measures shall be taken when insects/rodents are found to be present. • If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor. • Holes in the ground located in and around the trees shall be filled.

Appendix A
ARTICLE 28.090 OF THE CITY DEVELOPMENT CODE

INTRODUCTION

Appendix B
SANTA BARBARA URBAN HYDROGRAPH METHOD

INTRODUCTION

The Santa Barbara Urban Hydrograph (SBUH) method was developed by the Santa Barbara County Flood Control and Water Conservation District to determine a runoff hydrograph for an urbanized area. It is a simpler method than some other approaches, as it computes a hydrograph directly without going through intermediate steps (i.e., a unit hydrograph) to determine the runoff hydrograph.

The SBUH method is a popular method for calculating runoff, since it can be done with a spreadsheet or by hand relatively easily. The SBUH method is the method approved by the City of Grants Pass for determining runoff when doing flow control calculations.

ELEMENTS OF THE SBUH METHOD

The SBUH method depends on several variables:

- Pervious (A_P) and impervious (A_{imp}) land areas
- Time of concentration (T_c) calculations
- Runoff curve numbers (CN) applicable to the site
- Design storm

These elements shall all be presented as part of the submittal process for review by City staff. In addition, maps showing the pre-development and post-development conditions shall be presented to the City to help in the review.

Land Area

The total area, including the pervious and impervious areas within a drainage basin, shall be quantified in order to evaluate critical contributing areas and the resulting site runoff. Each area within a basin shall be analyzed separately and their hydrographs combined to determine the total basin hydrograph. Areas shall be selected to represent homogenous land use/development units.

Time of Concentration

Time of concentration, T_c, is the time for a theoretical drop of water to travel from the furthest point in the drainage basin to the facility being designed. (In this case, T_c is derived by calculating the overland flow time of concentration and the channelized flow time of concentration.) T_c depends on several factors, including ground slope, ground roughness, and distance of flow. The following formula for determining T_c should be used.

Formulas

$T_c = T_{c1} + T_{c2} + T_{c3} + \ldots + T_{cn}$

$T_c = L/60V$ (Conversion of velocity to travel time)

$T_c = \frac{0.42\,(nL)^{0.8}}{3.0(s)^{0.4}}$ (Manning's kinematic solution for sheet flow less than 300 feet)

(Shallow concentrated flow for slopes less than 0.005 ft/ft. For steeper slopes, sheet flow will occur for less distance and shallow concentrated flow will develop. For steep slope sites use the following equations as appropriate for site conditions:

$V = 16.1345(s)^{0.5}$ (Unpaved surfaces)

$V = 20.3282(s)^{0.5}$ (Paved surfaces)

Where,

- T_t = travel time, minutes
- T_c = total time of concentration, minutes (minimum T_c = 5 minutes)
- L = flow length, feet
- V = average velocity of flow, feet per second
- n = Manning's roughness coefficient for various surfaces (concrete, asphalt, and bare soil, n ranges from 0.01 to 0.016)
- s = slope of the hydraulic grade line (land or watercourse slope), feet per foot

When calculating T_c, the following limitations apply:

- Overland sheet flow (flow across flat areas that does not form into channels or rivulets) shall not extend for more than 300 feet. In steep locations sheet flow may be limited to as little as 100 feet.

- For flow paths through closed conveyance facilities such as pipes and culverts, standard hydraulic formulas shall be used for establishing velocity and travel time..

- Flow paths through lakes or wetlands may be assumed to be zero (i.e. $T_c = 0$).

Runoff Curve Numbers

Runoff curve numbers were developed by the Natural Resources Conservation Service (NRCS) after studying the runoff characteristics of various types of land. Curve numbers (CN) were developed to reduce diverse characteristics such as soil type, land usage, and vegetation into a single variable for doing runoff calculations. The runoff curve numbers approved by the City for water quantity/quality calculations are included as Table B-2 of this appendix.

The curve numbers presented in Table B-2 are for *wet* antecedent moisture conditions. Wet conditions assume previous rainstorms have reduced the capacity of soil to absorb water. Given the frequency of rainstorms, wet conditions are most likely, and give conservative hydrographic values.

Design Storm

The SBUH method also requires a design storm to perform the runoff calculations. For flow control calculations, the City uses a NRCS Type 1A 24-hour storm distribution. This storm is shown in Figure B-1 and Table B-4. The depth of rainfall for the 2 through 100-year storm events is shown below in Table B-1.

Table B-1
24-HOUR RAINFALL DEPTHS AT GRANTS PASS

Recurrence Interval, Years	2	5	10	25	100
24-Hour Depths, Inches	3.0	3.6	4.2	5.0	6.0

Table B-2
RUNOFF CURVE NUMBERS

Runoff curve numbers for urban areas*

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area	A	B	C	D
Open space (lawns, parks, golf courses, cemeteries, etc.):					
Poor condition (grass cover <50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82

Runoff curve numbers for other agricultural lands*

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range-continuous forage for grazing					
<50% ground cover or heavily grazed with no mulch	Poor	68	79	86	89
50 to 75% ground cover and not heavily grazed	Fair	49	69	79	84
>75% ground cover and lightly or only occasionally grazed	Good	39	61	74	80
Meadow-continuous grass, protected from grazing and generally mowed for hay	-	30	58	71	78
Brush--weed-grass mixture with brush as the major element					
<50% ground cover	Poor	48	67	77	83
50 to 75% ground cover	Fair	35	56	70	77
>75% ground cover	Good	30	48	65	73
Woods-grass combination (orchard or tree farm)	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79

Runoff curve numbers for other agricultural lands*

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Woods					
Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.	Poor	45	66	77	83
Woods are grazed but not burned, and some forest litter covers the soil.	Fair	36	60	73	79
Woods are protected from grazing, and litter and brush adequately cover the soil.	Good	30	55	70	77

Runoff curve numbers for Simplified Approaches**

Cover description		Curve numbers for hydrologic soil group			
Simplified Approaches	Hydrologic condition	A	B	C	D
Eco-roof	Good	n/a	61	n/a	n/a
Roof Garden	Good	n/a	48	n/a	n/a
Contained Planter Box	Good	n/a	48	n/a	n/a
Infiltration & Flow-Through Planter Box	Good	n/a	48	n/a	n/a
Pervious Pavement	-	76	85	89	n/a
Trees					
New and/or Existing Evergreen	-	36	60	73	79
New and/or Existing Deciduous	-	36	60	73	79

n/a - Does not apply, as design criteria for the relevant mitigation measures do not include the use of this soil type.
*Soil Conservation Service, *Urban Hydrology for Small Watersheds*, Technical Release 55, pp. 2.5-2.8, June 1986.
**CNs of various cover types were assigned to the Proposed Simplified Approaches with similar cover types as follows:

Eco-roof – assumed grass in good condition with soil type B.
Roof Garden – assumed brush-weed-grass mixture with >75% ground cover and soil type B.
Contained Planter Box – assumed brush-weed-grass mixture with >75% ground cover and soil type B.
Infiltration & Flow-Through Planter Box – assumed brush-weed-grass mixture with >75% ground cover and soil type B.
Pervious Pavement – assumed gravel.
Trees – assumed woods with fair hydrologic conditions.

Note: To determine hydrologic soil type, consult local USDA Soil Conservation Service Soil Survey.

TABLE B-3
NRCS HYDROLOGIC SOIL GROUP DESCRIPTIONS

NRCS Hydrologic Soil Group	Description
Group A	Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.
Group B	Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
Group C	Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.
Group D	Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a fragipan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Figure B-1 - NRCS 24-Hour Type 1A Hyetograph

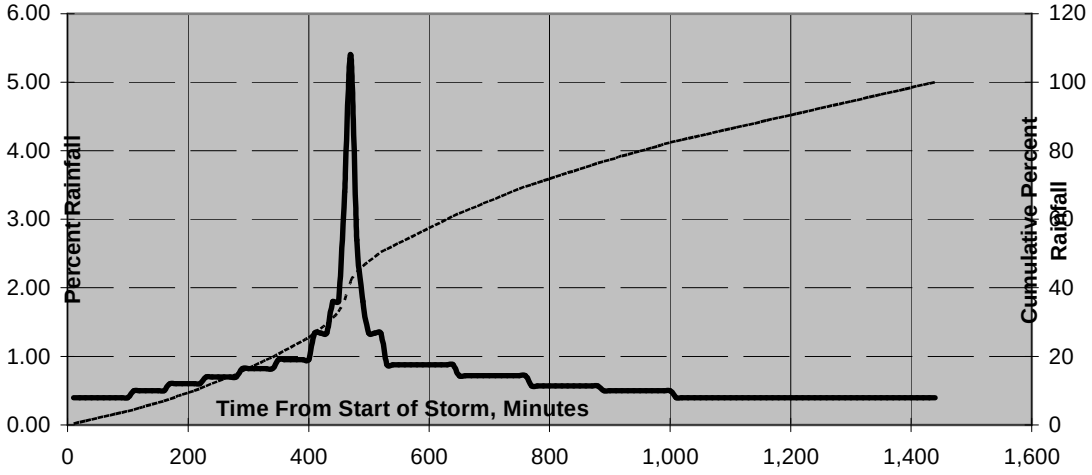


Table B-3 - NRCS Type 1A Hyetographic Distrubution - For Use In Water Quality/Quantity Design

Time From Start of Storm, Minutes	% Rainfall	Cumulative % Rainfall	Time From Start of Storm, Minutes	% Rainfall	Cumulative % Rainfall	Time From Start of Storm, Minutes	% Rainfall	Cumulative % Rainfall	Time From Start of Storm, Minutes	% Rainfall	Cumulative % Rainfall
0 - 10	0.40	0.40	360 - 370	0.95	22.57	720 - 730	0.72	67.40	1080 - 1090	0.40	86.00
10 - 20	0.40	0.80	370 - 380	0.95	23.52	730 - 740	0.72	68.12	1090 - 1100	0.40	86.40
20 - 30	0.40	1.20	380 - 390	0.95	24.47	740 - 750	0.72	68.84	1100 - 1110	0.40	86.80
30 - 40	0.40	1.60	390 - 400	0.95	25.42	750 - 760	0.72	69.56	1110 - 1120	0.40	87.20
40 - 50	0.40	2.00	400 - 410	1.34	26.76	760 - 770	0.57	70.13	1120 - 1130	0.40	87.60
50 - 60	0.40	2.40	410 - 420	1.34	28.10	770 - 780	0.57	70.70	1130 - 1140	0.40	88.00
60 - 70	0.40	2.80	420 - 430	1.34	29.44	780 - 790	0.57	71.27	1140 - 1150	0.40	88.40
70 - 80	0.40	3.20	430 - 440	1.80	31.24	790 - 800	0.57	71.84	1150 - 1160	0.40	88.80
80 - 90	0.40	3.60	440 - 450	1.80	33.04	800 - 810	0.57	72.41	1160 - 1170	0.40	89.20
90 - 100	0.40	4.00	450 - 460	3.40	36.44	810 - 820	0.57	72.98	1170 - 1180	0.40	89.60
100 - 110	0.50	4.50	460 - 470	5.40	41.84	820 - 830	0.57	73.55	1180 - 1190	0.40	90.00
110 - 120	0.50	5.00	470 - 480	2.70	44.54	830 - 840	0.57	74.12	1190 - 1200	0.40	90.40
120 - 130	0.50	5.50	480 - 490	1.80	46.34	840 - 850	0.57	74.69	1200 - 1210	0.40	90.80
130 - 140	0.50	6.00	490 - 500	1.34	47.68	850 - 860	0.57	75.26	1210 - 1220	0.40	91.20
140 - 150	0.50	6.50	500 - 510	1.34	49.02	860 - 870	0.57	75.83	1220 - 1230	0.40	91.60
150 - 160	0.50	7.00	510 - 520	1.34	50.36	870 - 880	0.57	76.40	1230 - 1240	0.40	92.00
160 - 170	0.60	7.60	520 - 530	0.88	51.24	880 - 890	0.50	76.90	1240 - 1250	0.40	92.40
170 - 180	0.60	8.20	530 - 540	0.88	52.12	890 - 900	0.50	77.40	1250 - 1260	0.40	92.80
180 - 190	0.60	8.80	540 - 550	0.88	53.00	900 - 910	0.50	77.90	1260 - 1270	0.40	93.20
190 - 200	0.60	9.40	550 - 560	0.88	53.88	910 - 920	0.50	78.40	1270 - 1280	0.40	93.60
200 - 210	0.60	10.00	560 - 570	0.88	54.76	920 - 930	0.50	78.90	1280 - 1290	0.40	94.00
210 - 220	0.60	10.60	570 - 580	0.88	55.64	930 - 940	0.50	79.40	1290 - 1300	0.40	94.40
220 - 230	0.70	11.30	580 - 590	0.88	56.52	940 - 950	0.50	79.90	1300 - 1310	0.40	94.80
230 - 240	0.70	12.00	590 - 600	0.88	57.40	950 - 960	0.50	80.40	1310 - 1320	0.40	95.20
240 - 250	0.70	12.70	600 - 610	0.88	58.28	960 - 970	0.50	80.90	1320 - 1330	0.40	95.60
250 - 260	0.70	13.40	610 - 620	0.88	59.16	970 - 980	0.50	81.40	1330 - 1340	0.40	96.00
260 - 270	0.70	14.10	620 - 630	0.88	60.04	980 - 990	0.50	81.90	1340 - 1350	0.40	96.40
270 - 280	0.70	14.80	630 - 640	0.88	60.92	990 - 1000	0.50	82.40	1350 - 1360	0.40	96.80
280 - 290	0.82	15.62	640 - 650	0.72	61.64	1000 - 1010	0.40	82.80	1360 - 1370	0.40	97.20
290 - 300	0.82	16.44	650 - 660	0.72	62.36	1010 - 1020	0.40	83.20	1370 - 1380	0.40	97.60
300 - 310	0.82	17.26	660 - 670	0.72	63.08	1020 - 1030	0.40	83.60	1380 - 1390	0.40	98.00
310 - 320	0.82	18.08	670 - 680	0.72	63.80	1030 - 1040	0.40	84.00	1390 - 1400	0.40	98.40
320 - 330	0.82	18.90	680 - 690	0.72	64.52	1040 - 1050	0.40	84.40	1400 - 1410	0.40	98.80
330 - 340	0.82	19.72	690 - 700	0.72	65.24	1050 - 1060	0.40	84.80	1410 - 1420	0.40	99.20
340 - 350	0.95	20.67	700 - 710	0.72	65.96	1060 - 1070	0.40	85.20	1420 - 1430	0.40	99.60
350 - 360	0.95	21.62	710 - 720	0.72	66.68	1070 - 1080	0.40	85.60	1430 - 1440	0.40	100.00

Appendix C
SIMPLIFIED APPROACH SIZING CALCULATIONS

The spreadsheet columns are described below:

Column (1)	Time in Minutes
Column (2)	Inflow for Storm Event (25-Year Detention Storm 3.9"/24 hours) and Contributing Impervious Area (1 acre)
Column (3)	Inflow (cf) = Inflow (cfs) x 60 x 10
Column (4)	Inflow (in) = Inflow (cf) x 12 / 43,560
Column (5)	Cumulative Inflow (in) = inflow (in) + Cumulative inflow (in) of previous step
Column (6)	Max Outflow (cfs) = Facility Area (sf) x Infiltration Rate (ft/s) **Note: Infiltration rate is assumed to be 2.5"/hr in this case. Also, for simplicity head is not taken into account.**
Column (7)	Cumulative Outflow (cf) = outflow (cfs) x 10 x 60 + cumulative outflow (cf) of previous step
Column (8)	Inflow – Outflow (cfs) = Column 2 inflow (cfs) – Column 6 outflow (cfs)
Column (9)	Incremental inflow – outflow (cf) = inflow – outflow (cfs) x 10 x 60
Column (10)	Cumulative inflow – outflow (cf) = If incremental inflow – outflow (cf) + cumulative inflow – outflow (cf) of previous step is less than 0, 0; else = incremental inflow – outflow (cf) + cumulative inflow – outflow (cf) of previous time step
Column (11)	Cumulative depth (in) = cumulative inflow – outflow (cf) x 12 / Facility Area (sf) **Note that cumulative depth does not exceed 6 inches in this case, which would result in an overflow condition. When modeling for detention purposes, overflow is allowed, but only at pre-developed peak rates. When modeling for pollution reduction, the entire post-developed runoff rate from the pollution reduction storm must be infiltrated without overflow.** **Resulting swale square-footage is 3,940, which when divided by the 43,560 square-foot impervious surface equals the 0.09 sizing factor.**

Spreadsheet Illustrating Vegetated Swale Sizing: 43,560 sq-ft imp. 25 yr storm **Swale Square Footage= 3940**
B Soil Infiltration Rate=2.5"/hr= .21 ft/hr= 0.00006 ft/s

(1) Time (min)	(2) Inflow (cfs)	(3) Inflow Volume (cf)	(4) Inflow Volume (in)	(5) Cumulative Inflow (in)	(6) Max Outflow (cfs)	(7) Cumulative Outflow Vol. (cf)	(8) Inflow - Outflow (cfs)	(9) Incremental Inflow - Outflow (cf)	(10) Cumulative Inflow - Outflow (cf)	(11) Cumulative Depth (in)
0	0	0	0.00	0.00	0.2364	0	-0.2364	-141.84	0	0
10	0	0	0.00	0.00	0.2364	141.84	-0.2364	-141.84	0	0
20	0	0	0.00	0.00	0.2364	283.68	-0.2364	-141.84	0	0
30	0	0	0.00	0.00	0.2364	425.52	-0.2364	-141.84	0	0
40	0.01	6	0.00	0.00	0.2364	567.36	-0.2264	-135.84	0	0
50	0.02	12	0.00	0.00	0.2364	709.2	-0.2164	-129.84	0	0
60	0.03	18	0.00	0.01	0.2364	851.04	-0.2064	-123.84	0	0
70	0.03	18	0.00	0.01	0.2364	992.88	-0.2064	-123.84	0	0
80	0.04	24	0.01	0.02	0.2364	1134.72	-0.1964	-117.84	0	0
90	0.05	30	0.01	0.03	0.2364	1276.56	-0.1864	-111.84	0	0
100	0.05	30	0.01	0.04	0.2364	1418.4	-0.1864	-111.84	0	0
110	0.06	36	0.01	0.05	0.2364	1560.24	-0.1764	-105.84	0	0
120	0.08	48	0.01	0.06	0.2364	1702.08	-0.1564	-93.84	0	0
130	0.08	48	0.01	0.07	0.2364	1843.92	-0.1564	-93.84	0	0
140	0.08	48	0.01	0.09	0.2364	1985.76	-0.1564	-93.84	0	0
150	0.09	54	0.01	0.10	0.2364	2127.6	-0.1464	-87.84	0	0

160	0.09	54	0.01	0.12	0.2364	2269.44	-0.1464	-87.84	0	0
170	0.1	60	0.02	0.13	0.2364	2411.28	-0.1364	-81.84	0	0
180	0.11	66	0.02	0.15	0.2364	2553.12	-0.1264	-75.84	0	0
190	0.12	72	0.02	0.17	0.2364	2694.96	-0.1164	-69.84	0	0
200	0.12	72	0.02	0.19	0.2364	2836.8	-0.1164	-69.84	0	0
210	0.12	72	0.02	0.21	0.2364	2978.64	-0.1164	-69.84	0	0
220	0.12	72	0.02	0.23	0.2364	3120.48	-0.1164	-69.84	0	0
230	0.13	78	0.02	0.25	0.2364	3262.32	-0.1064	-63.84	0	0
240	0.15	90	0.02	0.28	0.2364	3404.16	-0.0864	-51.84	0	0
250	0.15	90	0.02	0.30	0.2364	3546	-0.0864	-51.84	0	0
260	0.15	90	0.02	0.33	0.2364	3687.84	-0.0864	-51.84	0	0
270	0.15	90	0.02	0.35	0.2364	3829.68	-0.0864	-51.84	0	0
280	0.15	90	0.02	0.38	0.2364	3971.52	-0.0864	-51.84	0	0
290	0.17	102	0.03	0.40	0.2364	4113.36	-0.0664	-39.84	0	0
300	0.18	108	0.03	0.43	0.2364	4255.2	-0.0564	-33.84	0	0
310	0.18	108	0.03	0.46	0.2364	4397.04	-0.0564	-33.84	0	0
320	0.18	108	0.03	0.49	0.2364	4538.88	-0.0564	-33.84	0	0
330	0.18	108	0.03	0.52	0.2364	4680.72	-0.0564	-33.84	0	0
340	0.18	108	0.03	0.55	0.2364	4822.56	-0.0564	-33.84	0	0
350	0.2	120	0.03	0.59	0.2364	4964.4	-0.0364	-21.84	0	0
360	0.21	126	0.03	0.62	0.2364	5106.24	-0.0264	-15.84	0	0
370	0.21	126	0.03	0.66	0.2364	5248.08	-0.0264	-15.84	0	0
380	0.22	132	0.04	0.69	0.2364	5389.92	-0.0164	-9.84	0	0
390	0.22	132	0.04	0.73	0.2364	5531.76	-0.0164	-9.84	0	0
400	0.22	132	0.04	0.77	0.2364	5673.6	-0.0164	-9.84	0	0
410	0.26	156	0.04	0.81	0.2364	5815.44	0.0236	14.16	14.16	0.04830213
420	0.31	186	0.05	0.86	0.2364	5957.28	0.0736	44.16	58.32	0.19893928
430	0.31	186	0.05	0.91	0.2364	6099.12	0.0736	44.16	102.48	0.34957644
440	0.36	216	0.06	0.97	0.2364	6240.96	0.1236	74.16	176.64	0.60254862
450	0.42	252	0.07	1.04	0.2364	6382.8	0.1836	110.16	286.8	0.97832284
460	0.6	360	0.10	1.14	0.2364	6524.64	0.3636	218.16	504.96	1.72250314
470	1.02	612	0.17	1.31	0.2364	6666.48	0.7836	470.16	975.12	3.32629766
480	0.94	564	0.16	1.46	0.2364	6808.32	0.7036	422.16	1397.28	4.76635614
490	0.52	312	0.09	1.55	0.2364	6950.16	0.2836	170.16	1567.44	5.34680040
500	0.37	222	0.06	1.61	0.2364	7092	0.1336	80.16	1647.6	5.62023959
510	0.31	186	0.05	1.66	0.2364	7233.84	0.0736	44.16	1691.76	5.77087675
520	0.31	186	0.05	1.71	0.2364	7375.68	0.0736	44.16	1735.92	5.92151390
530	0.26	156	0.04	1.76	0.2364	7517.52	0.0236	14.16	1750.08	5.96981604
540	0.21	126	0.03	1.79	0.2364	7659.36	-0.0264	-15.84	1734.24	5.91578314
550	0.21	126	0.03	1.82	0.2364	7801.2	-0.0264	-15.84	1718.4	5.86175025
560	0.21	126	0.03	1.86	0.2364	7943.04	-0.0264	-15.84	1702.56	5.80771736
570	0.21	126	0.03	1.89	0.2364	8084.88	-0.0264	-15.84	1686.72	5.75368446
580	0.21	126	0.03	1.93	0.2364	8226.72	-0.0264	-15.84	1670.88	5.69965157
590	0.21	126	0.03	1.96	0.2364	8368.56	-0.0264	-15.84	1655.04	5.64561868
600	0.21	126	0.03	2.00	0.2364	8510.4	-0.0264	-15.84	1639.2	5.59158578
610	0.21	126	0.03	2.03	0.2364	8652.24	-0.0264	-15.84	1623.36	5.53755289
620	0.21	126	0.03	2.07	0.2364	8794.08	-0.0264	-15.84	1607.52	5.48352
630	0.21	126	0.03	2.10	0.2364	8935.92	-0.0264	-15.84	1591.68	5.42948710
640	0.21	126	0.03	2.14	0.2364	9077.76	-0.0264	-15.84	1575.84	5.37545421
650	0.19	114	0.03	2.17	0.2364	9219.6	-0.0464	-27.84	1548	5.28048731
660	0.17	102	0.03	2.20	0.2364	9361.44	-0.0664	-39.84	1508.16	5.14458639
670	0.17	102	0.03	2.22	0.2364	9503.28	-0.0664	-39.84	1468.32	5.00868548
680	0.17	102	0.03	2.25	0.2364	9645.12	-0.0664	-39.84	1428.48	4.87278456
690	0.17	102	0.03	2.28	0.2364	9786.96	-0.0664	-39.84	1388.64	4.73688365
700	0.17	102	0.03	2.31	0.2364	9928.8	-0.0664	-39.84	1348.8	4.60098274
710	0.17	102	0.03	2.34	0.2364	10070.64	-0.0664	-39.84	1308.96	4.46508182
720	0.17	102	0.03	2.37	0.2364	10212.48	-0.0664	-39.84	1269.12	4.32918091
730	0.17	102	0.03	2.39	0.2364	10354.32	-0.0664	-39.84	1229.28	4.19328
740	0.17	102	0.03	2.42	0.2364	10496.16	-0.0664	-39.84	1189.44	4.05737908
750	0.17	102	0.03	2.45	0.2364	10638	-0.0664	-39.84	1149.6	3.92147817
760	0.17	102	0.03	2.48	0.2364	10779.84	-0.0664	-39.84	1109.76	3.78557725
770	0.15	90	0.02	2.50	0.2364	10921.68	-0.0864	-51.84	1057.92	3.60874233
780	0.13	78	0.02	2.52	0.2364	11063.52	-0.1064	-63.84	994.08	3.39097340
790	0.13	78	0.02	2.55	0.2364	11205.36	-0.1064	-63.84	930.24	3.17320446
800	0.13	78	0.02	2.57	0.2364	11347.2	-0.1064	-63.84	866.4	2.95543553
810	0.13	78	0.02	2.59	0.2364	11489.04	-0.1064	-63.84	802.56	2.73766659
820	0.13	78	0.02	2.61	0.2364	11630.88	-0.1064	-63.84	738.72	2.51989766
830	0.13	78	0.02	2.63	0.2364	11772.72	-0.1064	-63.84	674.88	2.30212873
840	0.13	78	0.02	2.65	0.2364	11914.56	-0.1064	-63.84	611.04	2.08435979
850	0.13	78	0.02	2.67	0.2364	12056.4	-0.1064	-63.84	547.2	1.86659086

860	0.13	78	0.02	2.70	0.2364	12198.24	-0.1064	-63.84	483.36	1.64882192
870	0.13	78	0.02	2.72	0.2364	12340.08	-0.1064	-63.84	419.52	1.43105299
880	0.13	78	0.02	2.74	0.2364	12481.92	-0.1064	-63.84	355.68	1.21328406
890	0.13	78	0.02	2.76	0.2364	12623.76	-0.1064	-63.84	291.84	0.99551512
900	0.12	72	0.02	2.78	0.2364	12765.6	-0.1164	-69.84	222	0.75727918
910	0.12	72	0.02	2.80	0.2364	12907.44	-0.1164	-69.84	152.16	0.51904324
920	0.12	72	0.02	2.82	0.2364	13049.28	-0.1164	-69.84	82.32	0.28080731
930	0.12	72	0.02	2.84	0.2364	13191.12	-0.1164	-69.84	12.48	0.04257137
940	0.12	72	0.02	2.86	0.2364	13332.96	-0.1164	-69.84	0	0
950	0.12	72	0.02	2.88	0.2364	13474.8	-0.1164	-69.84	0	0
960	0.12	72	0.02	2.90	0.2364	13616.64	-0.1164	-69.84	0	0
970	0.12	72	0.02	2.92	0.2364	13758.48	-0.1164	-69.84	0	0
980	0.12	72	0.02	2.94	0.2364	13900.32	-0.1164	-69.84	0	0
990	0.12	72	0.02	2.96	0.2364	14042.16	-0.1164	-69.84	0	0
1000	0.12	72	0.02	2.98	0.2364	14184	-0.1164	-69.84	0	0
1010	0.11	66	0.02	3.00	0.2364	14325.84	-0.1264	-75.84	0	0
1020	0.09	54	0.01	3.01	0.2364	14467.68	-0.1464	-87.84	0	0
1030	0.09	54	0.01	3.03	0.2364	14609.52	-0.1464	-87.84	0	0
1040	0.09	54	0.01	3.04	0.2364	14751.36	-0.1464	-87.84	0	0
1050	0.09	54	0.01	3.06	0.2364	14893.2	-0.1464	-87.84	0	0
1060	0.09	54	0.01	3.07	0.2364	15035.04	-0.1464	-87.84	0	0
1070	0.09	54	0.01	3.09	0.2364	15176.88	-0.1464	-87.84	0	0
1080	0.09	54	0.01	3.10	0.2364	15318.72	-0.1464	-87.84	0	0
1090	0.09	54	0.01	3.12	0.2364	15460.56	-0.1464	-87.84	0	0
1100	0.09	54	0.01	3.13	0.2364	15602.4	-0.1464	-87.84	0	0
1110	0.09	54	0.01	3.15	0.2364	15744.24	-0.1464	-87.84	0	0
1120	0.09	54	0.01	3.16	0.2364	15886.08	-0.1464	-87.84	0	0
1130	0.09	54	0.01	3.18	0.2364	16027.92	-0.1464	-87.84	0	0
1140	0.09	54	0.01	3.19	0.2364	16169.76	-0.1464	-87.84	0	0
1150	0.09	54	0.01	3.20	0.2364	16311.6	-0.1464	-87.84	0	0
1160	0.09	54	0.01	3.22	0.2364	16453.44	-0.1464	-87.84	0	0
1170	0.09	54	0.01	3.23	0.2364	16595.28	-0.1464	-87.84	0	0
1180	0.09	54	0.01	3.25	0.2364	16737.12	-0.1464	-87.84	0	0
1190	0.09	54	0.01	3.26	0.2364	16878.96	-0.1464	-87.84	0	0
1200	0.09	54	0.01	3.28	0.2364	17020.8	-0.1464	-87.84	0	0
1210	0.09	54	0.01	3.29	0.2364	17162.64	-0.1464	-87.84	0	0
1220	0.09	54	0.01	3.31	0.2364	17304.48	-0.1464	-87.84	0	0
1230	0.09	54	0.01	3.32	0.2364	17446.32	-0.1464	-87.84	0	0
1240	0.09	54	0.01	3.34	0.2364	17588.16	-0.1464	-87.84	0	0
1250	0.09	54	0.01	3.35	0.2364	17730	-0.1464	-87.84	0	0
1260	0.09	54	0.01	3.37	0.2364	17871.84	-0.1464	-87.84	0	0
1270	0.09	54	0.01	3.38	0.2364	18013.68	-0.1464	-87.84	0	0
1280	0.09	54	0.01	3.40	0.2364	18155.52	-0.1464	-87.84	0	0
1290	0.09	54	0.01	3.41	0.2364	18297.36	-0.1464	-87.84	0	0
1300	0.09	54	0.01	3.43	0.2364	18439.2	-0.1464	-87.84	0	0
1310	0.09	54	0.01	3.44	0.2364	18581.04	-0.1464	-87.84	0	0
1320	0.09	54	0.01	3.46	0.2364	18722.88	-0.1464	-87.84	0	0
1330	0.09	54	0.01	3.47	0.2364	18864.72	-0.1464	-87.84	0	0
1340	0.09	54	0.01	3.49	0.2364	19006.56	-0.1464	-87.84	0	0
1350	0.09	54	0.01	3.50	0.2364	19148.4	-0.1464	-87.84	0	0
1360	0.09	54	0.01	3.52	0.2364	19290.24	-0.1464	-87.84	0	0
1370	0.09	54	0.01	3.53	0.2364	19432.08	-0.1464	-87.84	0	0
1380	0.09	54	0.01	3.55	0.2364	19573.92	-0.1464	-87.84	0	0
1390	0.09	54	0.01	3.56	0.2364	19715.76	-0.1464	-87.84	0	0
1400	0.09	54	0.01	3.58	0.2364	19857.6	-0.1464	-87.84	0	0
1410	0.09	54	0.01	3.59	0.2364	19999.44	-0.1464	-87.84	0	0
1420	0.09	54	0.01	3.61	0.2364	20141.28	-0.1464	-87.84	0	0
1430	0.09	54	0.01	3.62	0.2364	20283.12	-0.1464	-87.84	0	0
1440	0.09	54	0.01	3.64	0.2364	20424.96	-0.1464	-87.84	0	0
1450	0.05	30	0.01	3.64	0.2364	20566.8	-0.1864	-111.84	0	0
1460	0	0	0.00	3.64	0.2364	20566.8	-0.2364	-141.84	0	0

Appendix D
FACILITY PLANTING & SOIL RECOMMENDATIONS

The plant list contained in the Portland Stormwater Manual was reviewed and compared with local native plant lists for the Middle Rogue Watershed and the Bear Creek Watershed. The recommended plants from the Portland Stormwater Manual matched with many of the species used in riparian planting, so the Portland list was included in its entirety.

D.1 RECOMMENDED PLANT LISTS

Ecoroof Recommended Plants:

Note: For additional descriptions of these plants visit the Bureau of Environmental Services website, www.cleanrivers-pdx.org. For Roof Garden plants, BES recommends using drought tolerant, self-sustaining native trees, shrubs and ecoroof plants.

Sedums and Succulents

Delosperma cooperi,	Ice plant
Delosperma nubegenum,	Ice plant
Sedum acre	Stonecrop
**Sedum album*	White Stonecrop
**Sedum telephium* varieties including 'Autumn Joy' and 'Variegatum'	Stonecrop
Sedum divergens	Stonecrop
Sedum hispanicum	Stonecrop
Sedum kamtschaticum	Stonecrop
**Sedum oreganum*	Oregon Stonecrop
Sedum sexangular	Stonecrop
**Sedum spathilifolium*	Stonecrop
**Sedum spurium* varieties	Stonecrop
**Sempervivum tectorum*,	Hens and Chicks

Herbaceous

Achillea millefolium,	Common Yarrow
Achillea ageratifolia,	Greek Yarrow
Achillea tomentosum,	Wooly Yarrow
Arenaria montana,	Sandwort
Artemesia 'Silver mound',	Artemesia
Aurinia saxatilis,	Alyssum saxatile
**Cerastium*,	Snow-in-Summer
Dianthus alwoodii,	Pink

Dianthus deltoides,	Maiden Pink
Erigeron discoideus,	Fleabane
Festuca glauca,	Blue Fescue
Fragaria vesca,	Woodland Strawberry
Gazania linearis var. 'CO gold',	Gazania
**Gilia capitata*,	Globe gilia
Lobularia maritima,	Sweet alyssum
Nierembergia repens,	Cup Flower
**Polypodium glycrrhiza,*	Licorice Fern
**Polystichum munitum*,	Sword Fern
Potentilla nepalensis,	Nepal Cinquefoil
Potentilla nuemaniana,	Cinquefoil
Thymus serphyllum,	Mother of Thyme
Thymus vulgaris,	Common Thyme
Veronica liwanensis,	Speedwell

* Indicates that BES has observed these plants surviving in ecoroof areas that do not receive summer irrigation. Most of these locations have moderate to deep shade. To date these plants appear very stressed by the end of summer, but they have comeback each year. It is likely that many of the other plants listed above could survive in such conditions without irrigation.

Contained Planter Box, Infiltration Planter Box, and Flow-Through Planter Box Recommended Plants:

Note: Generally, plants requiring **moist-wet** conditions are preferred for flow-through facilities; plants requiring **moist to dry** conditions are preferred for infiltration facilities.

Shrubs

Ceanothus velutinus,	Snowbrush- moist-dry
Cornus sericea,	Redtwig Dogwood- moist-wet
Gaultheria shallon,	Salal- moist-dry
Mahonia (or Berberis) aquifolium,	Tall Oregon Grape-moist-dry
Mahonia nervosa,	Dull Oregon Grape– moist-dry
Physocarpus capitatus,	Pacific Ninebark- moist-wet
Ribes sanguineum,	Red-flowering Current- moist-dry
Rosa gymnocarpa,	Baldhip Rose– moist-dry
Rosa nutkana,	Nootka Rose– moist-dry
Rosa pisocarpa,	Swamp Rose– moist-dry
Rubus parviflorus,	Thimbleberry– moist-dry
Symphoricarpos alba,	Common Snowberry- moist-dry
Viburnum edule,	Highbush Cranberry; Squashberry- moist

Large Shrubs/ Small Trees

Acer circinatum,	Vine Maple– moist-wet
Amelanchier alnifolia,	Western Saskatoon Serviceberry-dry
Crataegus douglasii (or *C. suksdorfii*),	Douglas' Black Hawthorn– moist-wet
Malus fusca,	Pacific Crab Apple– moist-wet
Oemleria cerasiformis,	Indian Plum– moist-dry
Philadelphus lewisii,	Mock Orange– moist-dry
Prunus emarginata (or *P. virginiana*),	Bitter Cherry- moist
Rhamnus purshiana,	Cascara– dry-wet
Salix hookeriana,	Piper's Willow– moist-wet
Salix scouleriana,	Scoulers Willow- moist-wet
Salix sessilifolia,	Soft leafed Willow– moist-wet
Salix sitchensis,	Sitka Willow– moist-wet
Spiraea douglasii,	Douglas Spiraea– moist-wet

Grass and Grass-Like Plants

Beckmannia syzigachne,	American Slough Grass– moist-wet
Bromus carinatus,	California Brome Grass- moist-dry
Bromus sitchensis,	Alaska Brome– moist-dry
Bromus vulgaris,	Columbia Brome Grass– moist-dry

Camassia quamash,	Common Camas-moist
Carex aperta,	Columbia Sedge– moist-wet
Carex deweyanna,	Dewey Sedge– moist-wet
Carex obnupta,	Slough Sedge- moist-wet
Carex stipata,	Sawbeak Sedge– moist-wet
Deschampsia cespitosa,	Tufted Hairgrass- moist-dry
Eleocharis acicularis,	Needle Spike-Rush- moist-wet
Eleocharis ovata,	Ovate Spike-Rush- moist-wet
Eleocharis palustris,	Creeping Spike-Rush- moist-wet
Elymus glaucus,	Blue Wildrye– moist-dry
Festuca occidentalis,	Western Fescue Grass– moist-dry
Festuca rubra var. commutata,	Western Red Fescue– moist-dry
Glycera occidentalis,	Western Mannagrass– moist-wet
Iris douglasiana,	Douglas Iris– moist-dry
Iris tenax,	Oregon Iris– moist-dry
Juncus effusus var. pacificus	Common Rush– moist-wet
Juncus effufus var. gracilis	Common Rush– moist-wet
Juncus ensifolius,	Dagger-leaf Rush- moist-wet
Juncus patens,	Grooved Rush, Spreading Rush, - moist-wet
Juncus tenuis,	Slender Rush– moist-wet
Scirpus acutus,	Hardstem Bulrush- moist-wet
Scirpus microcarpus,	Small Fruited Bulrush- moist-wet
Sedum oreganum,	Oregon Sedum- dry
Sisyrinchium idahoense (or *S.angustifolium; S. bellum*),	Blue-eyed Grass– moist
Sisyrinchium douglasii,	Purple-Eyed Grass-moist

Ferns: Moist Shade

Athyrium felix-femina,	Lady Fern
Blechnum spicant,	Deer Fern
Polypodium glycrrhiza,	Licorice Fern
Polystichum munitum,	Sword Fern
Pteridium aquilinum,	Bracken Fern

Vegetated Swale and Vegetated Filter Strip Recommended Plants:

Planting zones
Swale bottom to 1.5 ft. up the side slope = wet to moist
Side slopes from 1.5 – 3 ft. = moist to dry
Side slopes above 3 ft. and upland = dry

Grasses and Groundcovers - Wet to Moist

Carex aperta,	Columbia Sedge
Carex obnupta,	Slough Sedge
Scirpus microcarpus,	Small flowered (or fruited) Bulrush
Hordeum brachyantherum,	Meadow Barley
Juncus effusus var. pacificus	Common Rush– moist-wet
Juncus effufus var. gracilis	Common Rush– moist-wet
Juncus ensifolius,	Dagger-leaf Rush
Juncus oxymeris,	Pointed Rush
Juncus tenuis,	Slender Rush
Juncus patens,	Grooved Rush; Spreading Rush
Glyceria occidentalis,	Manna Grass

Ferns: Moist shade

Blechnum spicant,	Deer Fern
Polypodium gycrrhiza,	Licorice Fern
Polystichum munitum,	Sword Fern

Moist to dry

Arctostaphyllos uva-ursi,	Kinnick-innick Aster
Aster suspicatus,	Douglas' Aster
Bromus carinatus,	California Brome Grass
Bromus sitchensis,	Alaska Brome
Bromus vulgaris,	Columbia Brome Grass
Lupinus micranthus,	Small Flowered Lupine
Sisyrinchium idahoense,	Blue-eyed Grass
Camassia quamash,	Common Camas
Festuca occidentalis,	Western Fescue Grass
Deschampsia caespitosa,	Tufted Hairgrass
Elymus glaucus,	Blue Wildrye
Fragaria vesca or *F. virginiana*,	Woodland strawberry or Wild strawberry
Sisyrinchium idahoense,	Blue-eyed Grass

Shrubs- varying zones

Cornus sericea,	Redtwig Dogwood- moist-wet
Gaultheria shallon,	Salal- dry

Mahonia aquifolium,	Tall Oregon Grape- moist -dry
Mahonia nervosa,	Dull Oregon Grape- moist-dry
Physocarpus capitatus,	Pacific Ninebark- moist-wet
Ribes sanguineum,	Red-flowering Current-dry
Rosa gymnocarpa,	Baldhip Rose– moist -dry
Rosa nutkana,	Nootka Rose– moist-dry
Rosa pisocarpa,	Swamp Rose– moist-dry
Spiraea betulifolia,	Shiny-leaf Spiraea - dry
Symphoricarpos alba,	Common Snowberry- moist-dry
Viburnum edule,	Highbush Cranberry; Squashberry- moist -dry

Large Shrub/Small Tree– varying zones

Acer circinatum,	Vine Maple- moist-wet
Amelanchier alnifolia,	Western Saskatoon Serviceberry- dry
Ceanothus sanguineus,	Oregon Redstem Ceanothus- moist-dry
Corylus cornuta,	Western Beaked Hazelnut- moist-dry
Crataegus douglasii,	Douglas' Black Hawthorn- moist
Holodiscus discolor,	Oceanspray- moist-dry
Malus fusca,	Pacific Crab Apple- moist-wet
Oemleria cerasiformis,	Indian Plum; Osoberry- moist-wet
Philadelphis lewesii,	Mock Orange- moist-dry
Prunus emarginata or *P.Virginiana*	Bitter or Choke Cherry- moist
Rhamnus purshiana,	Cascara- dry-wet
Rosa nutkana,	Nootka Rose- moist-dry
Rubus parviflorus,	Thimbleberry- moist-dry
Salix fluviatalis,	Columbia Willow- moist-wet
Salix hookeriana,	Piper's Willow- moist-wet
Salix lucida (or S. *lasiandra*),	Pacific Willow- moist-wet
Salix scouleriana,	Scoulers Willow-moist-wet
Salix sessilifolia,	Soft leafed Willow- moist-wet
Salix sitchensis,	Sitka Willow- moist-wet
Sambucus cerulea,	Blue Elderberry- moist- dry
Sambucus racemosa,	Red Elderberry- moist- dry

Conifer and Evergreen Trees- varying zones

Abies grandis,	Grand Fir- moist-dry
Arbutus menziesii,	Madrone- dry
Pinus monticola,	Western White Pine- moist-dry
Pinus ponderaosa,	Ponderosa Pine- dry
Pseudotsuga menziesii,	Douglas Fir- moist-dry
Thuja plicata,	Western Red Cedar- moist-wet
Tsuga heterophylla,	Western hemlock-moist

Deciduous Trees- varying zones

Acer macrophyllum,	Big leaf Maple- moist-dry
Alnus rubra,	Red Alder - moist-wet
Amelanchier alnifolia,	Serviceberry - dry
Cornus nuttallii,	Western Flowering Dogwood– moist-dry
Fraxinus latifolia,	Oregon Ash - moist-wet
Populus balsamifera,	Black Cottonwood – moist-wet
Quercus chrysolopsis,	Canyon Live Oak - dry
Quercus garryana,	Oregon White Oak – moist-dry

Grassy Swale Recommended Seed Mixes:

See **Exhibit F-1** for grass seed recommendations and specifications.

Vegetated Infiltration Basin and Dry Detention Pond Recommended Plants:

Planting zones
Basin bottom to 1.5 ft. up the side slope = moist
Side slopes from 1.5 – 3 ft. = moist to dry
Side slopes above 3 ft. and upland = dry

Note: These plants are recommended based on experience and/or literature review. For soils with slow infiltration rates (< 2 inches per hour) moist to wet plants are preferable; for soils with higher infiltration rates moist to dry plants are preferable.

Grasses and groundcovers: See **Exhibit F-1** for grass seed recommendations and specifications.

Moist –

Beckmannia syzigachne,	American Slough Grass
Carex aperta,	Columbia Sedge
Carex densa,	Dense Sedge
Carex deweyana,	Dewey Sedge
Carex hendersonii,	Henderson Sedge
Carex obnupta,	Slough Sedge
Carex stipata,	Sawbeak Sedge
Carex vesicaria,	Inflated Sedge
Eleocharis acicularis,	Needle Spike-rush
Eleocharis ovata,	Ovate Spike-rush
Eleocharis palustris,	Creeping Spike-rush
Juncus effusus,	Common/Soft Rush
Juncus ensifolius,	Dagger-leaf Rush
Juncus patens,	Grooved Rush; Spreading Rush
Juncus tenuis,	Slender Rush
Scirpus acutus,	Hardstem Bulrush
Scirpus americanus,	Three-square or American Bulrush
Scirpus microcarpus,	Small Fruited Bulrush

Moist to Dry

Aster suspicatus,	Douglas' Aster
Bromus carinatus,	California Brome Grass
Bromus sitchensis,	Alaska Brome

Bromus vulgaris,	Columbia Brome Grass
Camassia quamash,	Common Camas
Festuca occidentalis,	Western Fescue Grass
Deschampsia caespitosa,	Tufted Hairgrass
Elymus glaucus,	Blue Wildrye
Fragaria vesca or F. virginiana,	Woodland strawberry or Wild strawberry
Hordeum brachyantherum,	Meadow Barley
Iris tenax,	Oregon Iris
Lupinus micranthus,	Small Flowered Lupine
Sisyrinchium idahoense,	Blue-eyed Grass

Ferns: Moist shade

Blechnum spicant,	Deer Fern
Polypodium gycrrhiza,	Licorice Fern
Polystichum munitum,	Sword Fern
Athyrium felix-femina,	Lady Fern

Shrubs: moist

Cornus sericea,	Red-stemmed or Red-osier Dogwood
Salix hookeriana,	Hookers Willow
Salix lucida var. 'lasiandra',	Pacific Willow
Salix sitchensis,	Sitka Willow
Salix scouleriana,	Scouler's Willow
Salix fluviatalis,	Columbia Willow
Sambucus racemosa,	Red Elderberry
Physocarpis capitatus,	Pacific Ninebark
Spiraea douglasii,	Douglas Spirea
Crataegus douglasii,	Black Hawthorn
Rhamnus purshiana,	Cascara
Rubus spectabilis,	Salmonberry
Rosa pisocarpa,	Swamp Rose

Shrubs: (moist-dry)

Acer circinatum,	Vine maple
Ceanothus sanguineous,	Oregon Redstem Ceanothus
Ceanothus velutinus,	Snowbrush
Corylus cornuta,	Western Beaked Hazelnut
Gautheria shallon,	Salal
Holodiscus discolor,	Oceanspray
Mahonia aquifolium,	Tall Oregon Grape
Mahonia nervosa,	Dull Oregon Grape
Philadelphus lewisii,	Mock Orange
Ribes sanguineum,	Red Flowering Currant

Rosa gymnocarpa,	Baldhip Rose
Rosa nutkana,	Nootka Rose
Rubus parviflorus,	Thimbleberry
Spiraea betulifolia,	Shiny-leaf Spiraea
Symphoricarpus albus,	Snowberry
Viburnum edule,	Highbush Cranberry

Trees

Conifer and Evergreen Trees- varying zones

Abies Grandis,	Grand Fir- moist-dry
Arbutus menziesii,	Madrone- dry
Castanopsis chrysopylla,	Chinquapin- dry
Pinus monticola,	Western White Pine- moist-dry
Pinus Ponderaosa,	Ponderosa Pine- dry
Pseudotsuga menziesii,	Douglas Fir- moist-dry
Thuja plicata,	Western Red Cedar- moist-wet (prefers shade)
Tsuga heterophylla,	Western hemlock- moist

Deciduous Trees- varying zones

Acer macrophyllum,	Big leaf Maple – moist-dry
Alnus rubra,	Red Alder - moist-wet
Amelanchier alnifolia,	Serviceberry - dry
Cornus nuttalii,	Western Flowering Dogwood – moist-dry
Fraxinus latifolia,	Oregon Ash - moist-wet
Malus fusca,	Pacific crabapple - moist-wet
Oemleria cerasiformis,	Indian Plum - moist-dry
Populus balsamifera,	Black Cottonwood – moist-wet
Quercus garryana,	Oregon White Oak – moist-dry

Wet and Extended Wet Pond Recommended Plants:

Planting zones
Shallow water to 1 ft. up the side slope = wet to saturated
Side slopes from 1 – 3 ft. = moist to dry
Side slopes above 3 ft. and upland = dry

Wetland herbaceous plants (aquatic and emergent)
Emergent wet to saturated zone

Alisma plantago-aquatica,	Water Plantain
Carex obnupta,	Slough Sedge
Eleocharis ovata,	Ovate Spike rush
Eleocharis palustris,	Creeping Spike rush
**Lemna minor*,	Common Lesser Duckweed*
Myosotis laxa,	Small-flowered Forget-me-not
**Potamogeton natans*,	Floating-leafed Pondweed
**Sagittaria latifolia*,	Broadleaf Arrowhead; Wapato
Scirpus acutus,	Hardstem Bulrush
Sparganium emersum,	Narrowleaf Bureed

Moist to wet zone

Alopecurus geniculatus,	Water foxtail
Beckmannia syzigachne,	American Slough Grass
Carex aperta,	Columbia Sedge
Carex deweyana,	Dewey Sedge
Juncus effusus,	Common/Soft Rush
Juncus ensifolius,	Dagger-leaf Rush
Juncus oxymeris,	Pointed Rush
Juncus tenuis,	Slender Rush
Juncus patens,	Grooved Rush; Spreading Rush
Lupinus polyphyllus,	Large-leaved Lupine
Scirpus microcarpus,	Small flowered (or fruited) Bulrush

Grasses and Groundcovers: varying zones, see **Exhibit F-1** for grass seed recommendations and specifications.

Aster suspicatus,	Douglas' Aster- moist
Bidens cernua,	Nodding Beggarticks- moist -wet
Bromus sitchensis,	Alaska Brome- moist-dry
Camassia quamash,	Common Camas- moist
Deschampsia caespitosa,	Tufted Hairgrass- moist-dry
Elymus glaucus,	Blue Wildrye- moist-dry
Fragaria vesca or *F. virginiana*,	Woodland strawberry or wild strawberry- moist-dry

Glyceria occidentalis,	Western Mannagrass- moist-wet
Hordeum brachyantherum,	Meadow Barley- moist
Sisyrinchium idahoense,	Blue-eyed Grass- moist
Viola palustris,	Marsh Violet- moist- wet
Veronica americana,	Speedwell- moist-wet

Shrub: moist to saturated zones

Acer circinatum,	Vine Maple
Blechnum spicant,	Deer Fern
Cornus sericea,	Red-stemmed dogwood
Crateagus douglasii,	Black Hawthorn
Rhamnus purshiana,	Cascara
Rubus spectabilis,	Salmonberry
Rosa gymnocarpa,	Baldhip Rose
Rosa pisocarpa,	Swamp Rose
Oemlaria cerasiformis,	Indian Plum
Physocarpis capitatus,	Pacific Ninebark
Polystichum munitum,	Sword fern
Prunus emarginata,	Bitter Cherry
Salix fluviatalis,	Columbia Willow
Salix hookeriana,	Hookers Willow
Salix sitchensis,	Sitka Willow

Shrub: moist to dry zones

Mahonia aquifolium,	Tall Oregon Grape
Mahonia nervosa,	Dull Oregon Grape
Rosa nutkana,	Nootka Rose
Rubus parviflorus,	Thimbleberry
Spiraea betulifolia,	Shiny-leaf Spiraea
Symphoricarpus alba,	Snowberry
Sambucus racemosa,	Red Elderberry
Spiraea douglasii,	Douglas Spiraea
Viburnum edule,	Highbush Cranberry; Squashberry

Shrub dry zones

Corylus cornuta,	Western Beaked Hazelnut
Holodiscus discolor,	Oceanspray
Lonicera involucrata,	Black twinberry (moist-dry)
Mahonia aquifolium,	Tall Oregon Grape
Philadelphis lewesii,	Mock Orange
Ribes sanguineum,	Red Flowering Currant
Salix scouleriana,	Scouler's Willow

Conifer and Evergreen Trees - varying zones

Abies grandis,	Grand Fir- moist-dry
Arbutus menziesii,	Madrone- dry
Castinopsis chrysophylla,	Chinquapin- dry
Pinus ponderosa,	Ponderosa Pine- dry
Pinus monticola,	Western White Pine- dry-moist
Pseudotsuga menziesii,	Douglas Fir- moist-dry
Sequoia sempervirons,	Coast Redwood- moist
Thuja plicata,	Western Red Cedar- moist-wet
Tsuga heterophylla,	Western Hemlock- moist

Deciduous Trees - varying zones

Acer macrophyllum,	Big leaf Maple- moist- dry
Alnus rubra,	Red Alder- moist-wet
Amelanchier alnifolia,	Serviceberry- dry
Cornus nuttalii,	Western Flowering Dogwood- moist-dry
Fraxinus latifolia,	Oregon Ash- moist-wet
Malus fusca,	Pacific crabapple- moist-wet
Oemleria cerasiformis,	Indian Plum- moist-dry
Populus balsamifera,	Black Cottonwood- moist-wet
Salix lucida var.' lasiandra',	Pacific Willow- moist-wet
Quercus cyrsolepsis,	Canyon Live Oak- dry
Quercus garryana,	Oregon White Oak- moist-dry

SEED SPECIFICATIONS FOR STORMWATER MANAGEMENT MANUAL

Species listed below should only be used in the listed moisture regime for optimal success. *Sow rates for* ***small seeded mixes*** *shall contain a* ***minimum of 20 lbs/per acre in combination*** *for stormwater management facilities and* ***30 lbs/acre for erosion control*** *purposes.* ***Sow rates for large/medium seeded*** *mixes should contain a* ***minimum of 25 lbs per acre*** *in combination for stormwater management facilities and 40 pounds per acre* ***for erosion control*** *purposes.*

Common name	Scientific Name	Optimal Sow Season	Matrix or to add diversity?	Swale or Pond Sow Rate (Hand)	Erosion Control Sow Rate	Moisture	Exposure	Seed size	Commercial accessibility of local eco-type
Grasses									
American sloughgrass	Beckmannia syzigachne	fall/spring	D	2 lbs/ac	NR	inundated to wet	sun	medium	easy to medium, Willamette Valley
Blue wildrye	Elymus glaucus	early fall/spring	**M**	**25 lbs/ac**	40 lbs/acre	xeric to mesic	sun to shade	large	easy, Portland Metro
California brome	Bromus carinatus	early fall/spring	**M**	**25 lbs/ac**	40 lbs/acre	xeric to mesic	sun	large	easy, Portland Metro
California oatgrass	Danthonia californica	fall/spring	**M**	**30 lbs/ac**	NR		sun	large	easy to medium, Willamette Valley
Columbia brome	Bromus vulgaris	fall/spring	D	5 lbs/ac	NR	xeric to mesic	shade	large	medium, Portland Metro
Junegrass	Koeleria macrantha	fall/spring	**M**	**20 lbs/ac**	NR	xeric to mesic	sun	small	easy to medium, PDX or Willamette Valley
Meadow barley	Hordeum brachyantheru	early fall/spring	**M**	**25 lbs/ac**	40 lbs/acre	wet to mesic	sun	large	easy to medium, Willamette Valley
Pine bluegrass	Poa secunda								
Rice cutgrass	Leersia oryzoides	fall/spring	D	5 lbs/ac	NR	inundated to wet	sun	medium	medium to difficult, Portland Metro
Roemer's fescue	Festuca roemeri	fall/spring	D	2 lbs/ac	NR	xeric to mesic	sun	small	difficult, Willamette Valley
Sitka brome	Bromus sitchensis	early fall/spring	**M**	**25 lbs/ac**	40 lbs/acre	wet to mesic	sun/shade	large	easy, Willamette Valley
Slender hairgrass	Deschampsia elongata	early fall/spring	**M**	**20 lbs/ac**	30 lbs/acre	wet to xeric	sun	small	easy, Portland Metro
Slender wheatgrass	Elymus trachycaulus	early fall/spring	**M**	**25 lbs/ac**	40 lbs/acre	xeric to mesic	sun	large	medium to difficult, Willamette Valley
Spike bentgrass	Agrostis exarata	early fall/spring	D	5 lbs/ac	30 lbs/acre	saturated to wet	sun	small	easy to medium, Portland Metro
Tall mannagrass	Glyceria elata	fall/spring	D	2 lbs/ac	NR	saturated to mesic	shade	small	medium to difficult, Portland Metro
Tufted hairgrass	Deschampsia cespitosa	fall/spring	D	2 lbs/ac	NR	saturated to wet	sun	small	easy, Willamette Valley
Water foxtail	Alopecuris geniculatus	fall/spring	**M**	**25 lbs/ac**	NR	inundated to wet	sun	medium	easy, PDX or Willamette Valley
Western fescue	Festuca occidentalis	fall/spring	**M**	**20 lbs/ac**	NR	xeric to mesic	sun	small	medium to difficult, Willamette Valley
Western mannagrass	Glyceria occidentalis	fall/spring	**M**	**25 lbs/ac**	NR	saturated to wet	sun	medium	easy to medium, Willamette Valley
Sedges, Rushes - soil moisture as indicated into summer months									
Carex obnupta	Slough sedge	fall/spring	D	2 lbs/ac	NR	inundated to mesic	sun/shade	medium	medium to difficult, PDX
Carex scoparia	Pointed broom sedge	fall/spring	D	2 lbs/ac	NR	wet to mesic	sun	medium	medium to difficult, PDX
Carex stipata	Sawbeak sedge	fall/spring	D	2 lbs/ac	NR	inundated to mesic	sun	medium	medium, Willamette Valley
Eleocharis ovata	Ovate spikerush	fall/spring	D	1 lb/ac	NR	inundated to wet	sun	small	easy, PDX or Willamette Valley
Eleocharis palustris	Creeping spikerush	fall/spring	D	2 lbs/ac	NR	inundated to wet	sun	small	easy to medium, Willamette Valley
Juncus acuminatus	Tapertip rush	fall/spring	D	0.25 lbs/ac	NR	inundated to wet	sun	small	medium, Willamette Valley, PDX
Juncus bufonius	Toad rush	fall/spring	D	0.25 lbs/ac	NR	wet to mesic	sun	small	medium, Willamette Valley
Juncus patens	Spreading rush	fall/spring	D	0.50 lb/ac	NR	wet to mesic	sun/shade	small	easy, PDX
Forbs									
Achillea millefolium	Western Yarrow	fall	D	0.25 lbs/ac	NR	wet to mesic	sun	medium	easy, PDX or Willamette Valley
Aquilegia formosa	Western Columbine	fall	D	1.0 lb/ac	NR	wet to mesic	sun	medium	easy to medium, Willamette Valley
Alisma media	Water plantain	fall/spring	D	1.0 lb/ac	NR	inundated to wet	sun	medium	easy to medium, Willamette Valley
Collomia grandiflora	Large flowered collomia	fall/spring	D	.50 lbs/ac	NR	xeric to mesic	sun	small	medium to difficult, Willamette Valley
Collinsia rattanii	Blue eyed mary	fall/spring	D	.25 lbs/ac	NR	xeric to mesic	sun	small	medium to difficult, Willamette Valley
Epilobium densiflora	Dense spike primrose	fall	D	1.0 lb/ac	NR	wet to mesic	sun	small	medium, Willamette Valley
Eriophyllum lanatum	Wooly sunshine	fall	D	1.0 lb/ac	NR	wet to mesic	sun	medium	easy to medium, Willamette Valley
Gilia capitata	Blue gilia	fall/spring	D	2 lbs/acre	1 lb/ac (w/	xeric to mesic	sun	medium	medium, Willamette Valley
Lotus purshianus	Spanish clover	fall	D	2 lbs/acre	1 lb/ac (w/	xeric to mesic	sun	medium	medium, Willamette Valley
Lupinus albicaulis	Sickle keel lupine	fall	D	1 lb/ac	1 lb/ac (w/	xeric to mesic	sun	large	medium, Willamette Valley
Iris tenax	Oregon Iris	fall	D	2 lbs/ac	NR	xeric to mesic	sun	large	easy to medium, Willamette Valley
Camassia quamash	Common camas	fall	D	1 lb/ac	NR	wet to mesic	sun	medium	easy to medium, Willamette Valley
Camassia quamash va	Great camas	fall	D	1 lb/ac	NR	wet to mesic	sun	medium	easy to medium, Willamette Valley
Lupinus micranthus	Small flowered lupine	fall	D	1 lb/ac	NR	xeric to mesic	sun	medium	medium to difficult, Willamette Valley
Ranunculus occidental	Western buttercup	fall	D	1 lb/ac	NR	xeric to mesic	sun	medium	medium to difficult, Willamette Valley
Sidalcea campestris	Checker mallow	fall	D	1 lb/ac	NR	xeric to mesic	sun	large	medium to difficult, Willamette Valley
Lupinus rivularis	Stream lupine	fall	D	1 lb/ac	1 lb/ac (w/	xeric to mesic	sun	large	medium, Willamette Valley
Plagiobothrys figuratus	Popcorn flower	fall/spring	D	1.0 lb/ac	NR	inundated to wet	sun	small	medium to difficult, Willamette Valley
Prunella vulgaris var. la	Self heal	fall/spring	D	2 lbs/ac	1 lb/ac (w/	wet to mesic	sun/shade	medium	easy to medium, PDX or Willamette Valley
Solidago canadensis	Goldenrod	fall	D	0.50 lbs/ac	NR	xeric to mesic	sun	small	easy to medium, PDX or Willamette Valley
Recommended Non-Native Cover Crop Species									
Festuca rubra var. com	Chewings fescue	year round	M	20 lbs/ac	30-40				n/a
Triticum spp.	Wheat	year round	M	50 lbs/ac	60				n/a
Avena spp.	Oats	year round	M	50 lbs/ac	60				n/a
Regreen	Sterile wheat hybrid	year round	M	40 lbs/ac	50				n/a
Agropyron spp.	Wheatgrass	year round	M	30 lbs/acre	40				A. trachycaulus (W.V. source)

Nuisance Grass Species not recommended for use on Erosion Control or Stormwater Projects

Species	Common name	State Listed Noxious Weed?				City			
Agropyron repens	Quackgrass		yes (B-list)			Nuisance List Portland Plant List			
Alopecuris pratensis	Meadow foxtail		no			Nuisance List Portland Plant List			
Anthoxanthum odoratu	Sweet vernal grass		no			Nuisance List Portland Plant List			
Arrhenatherum elatius	Tall oatgrass		no			Nuisance List Portland Plant List			
Brachypodium sylvatic	False brome		yes (B-list)			Nuisance List Portland Plant List			
Bromus diandrus	Ripgut		no			Nuisance List Portland Plant List			
Bromus hordaceus	Smooth brome		no			Nuisance List Portland Plant List			
Bromus inermis	Smooth brome		no			Nuisance List Portland Plant List			
Bromus japonicus	Japanese brome		no			Nuisance List Portland Plant List			
Bromus sterilis	Poverty grass		no			Nuisance List Portland Plant List			
Bromus tectorum	Cheatgrass		no			Nuisance List Portland Plant List			
Festuca arundinacea	Tall fescue		no			Nuisance List Portland Plant List			
Holcus lanatus	Velvet grass		no			Nuisance List Portland Plant List			
Lolium multiflorum	Annual ryegrass		no			Nuisance List Portland Plant List			
Phalaria arundinacea	Reed canary grass		no			Nuisance List Portland Plant List			
Phalaris aquatica	Harding grass		no			Nuisance List Portland Plant List			
Phleum pratensis	Timothy		no			Nuisance List Portland Plant List			
Phragmites australis	Common reed		no			Nuisance List Portland Plant List			
Vulpia myoros	Rat-tailed fescue		no			Nuisance List Portland Plant List			

D.2 DESIGN CONCEPTS AND PRINCIPLES

The City Engineer requires developers to design stormwater facilities in project landscape areas, using surface retention facilities such as those shown in the simplified approach. The resulting integrated stormwater landscape can meet many, if not all, of Title 33 landscape requirements, applicable plan district requirements, and Title 17 requirements. The benefits of integrated designs include construction cost savings, combined maintenance, aesthetic benefits, and the greater likelihood of maintaining long-term functionality. A well-designed and established landscape will also prevent post-construction soil erosion. These approaches can also help reduce urban heat island effects and contribute to other sustainable principles.

An integrated design may require changing the size of some site elements. For example, Title 33.266 parking code allows parking layout and dimensions to be designed to allow more space for simplified approach facilities. Also see Parking lot Design Tips in Chapter 2 of this document.

In order to integrate stormwater management with the project landscape areas, it is essential that impervious surface grading be directed toward the stormwater facility areas. Surface stormwater facilities also must be depressed to allow sheet flow into the area. Since these design approaches are still new to many construction contractors it is advisable to clearly show these details in cross section and plan view drawings.

Pollution Prevention

Stormwater pollution prevention practices related to landscaping can be categorized into two broad categories:

- Toxic Substance Use Reduction
- Pollutant Source Reduction

Toxic Substance Use Reduction

Projects shall be designed to minimize the need for toxic or potentially polluting materials such as herbicides, pesticides, fertilizers, or petroleum based fuels within the facility area before, during, and after construction. Use of these materials creates the risk of spills, misuse, and future draining or leaching of pollutants into facilities or the surrounding area.

Pollutant Source Reduction

Materials that could leach pollutants or pose a hazard to people and wildlife shall not be used as components of a stormwater facility. Some examples of these materials are chemically treated railroad ties and lumber and galvanized metals. Many alternatives to these materials are available.

Soils

Soil analysis shall be conducted **within the stormwater facility area** to determine the viability of soils to assure healthy tree and vegetation growth and to provide adequate infiltration rates through the topsoil, or soil in these areas shall be amended. These tests can help the designer specify appropriate levels and types of soil amendments.

Projects should stockpile existing topsoil for re-use on the site to minimize the need to import topsoil. Appropriate erosion control measures shall be used. Soil analysis tests shall be performed on stockpiled soil if it will be used within the facility area.

Topsoil is not required to be placed in the bottom of wet ponds or constructed wetland areas having a permanent pool depth of 6" or more. At the time of final inspection all surface area soils shall be covered with plants and/or mulch sufficient to prevent erosion.

Site Preparation and Grading

Unwanted vegetation in the facility area shall be removed during site preparation with equipment appropriate for the type of material encountered and site conditions. It is recommended that the maximum amount of pre-existing native vegetation be retained and protected.

No material storage or heavy equipment is allowed within the stormwater facility area after site clearing and grading has been completed, except to excavate and grade as needed to build the facility.

After the facility area is cleared and graded, all disturbed subsoil shall be tilled before capping with 18 inches of topsoil. If existing areas surrounding the stormwater facility are disturbed by construction, the top 18 inches of soil shall be tilled. No tilling shall occur within the drip line of existing trees. After tilling is completed, no other construction traffic shall be allowed in the area, except for planting and related work.

All construction and other debris shall be removed before topsoil is placed. Unless otherwise specified, the City will expect the landscape contractor to be responsible for

final grading and for ensuring that surface and stormwater runoff flows are functioning as designed.

Mulch

Approved mulching materials and practices include organic materials such as compost, bark mulch, leaves, sawdust, straw, or wood shavings, as well as small river gravel, pumice, or other inert materials, applied in a 1-foot radius (measured from the center of the plant) around specific trees or shrubs. For ground cover plantings, the mulch shall be applied to cover all soil between plants. Care should be exercised to use the appropriate amount of mulch. Over-use can cause excessive nutrients to leach into the facility. Mulch shall be weed-free. Manure mulching and high-fertilizer hydroseeding are prohibited in a facility area during and after construction.

Irrigation

Permanent irrigation systems are not allowed for City maintained facilities, unless approved by the City. Temporary irrigation systems or alternative methods of irrigation for landscape establishment shall be specified. Permanent irrigation systems are allowed for private facilities, but designers are encouraged to minimize the need for permanent irrigation. Innovative methods for watering vegetation are encouraged, such as the use of cisterns and air conditioning condensate.

Facility Screening

Facility elements such as chain link fences, concrete bulkheads, outfalls, rip-rap, gabions, large steel grates, steep side slopes, manhole covers/vault lids, berm embankments planted only with grasses, exposed pipe, blank retaining walls greater than 2 feet high, and access roads are generally not aesthetic. When these elements are part of City-maintained facilities or private facilities that face public right-of-way or other private property, the City requires them to be screened with plant materials. The quantities of landscape materials that are required by this chapter have been estimated to provide sufficient screening in most of the stormwater facilities. Attention will need to be paid to site conditions that may require adjustments in planting layout and/or the need for additional trees and shrubs. It is not the intent of this screening requirement to dictate a specific solution such as a linear hedge. Designers are encouraged to integrate the facility landscaping with the screening objective. Designers can also use more decorative materials providing they are attractive and meet the intent of city code.

Commercial Sources for Native Plant Material

Bareroot (Seedling) Trees/ Shrubs

Balance Restoration Nursery	541-942-5530 (fax & phone)
Wallace Hansen Nursery	503-581-2638, fax 503-581-9957
D.L. Phipps State Forest Nursery	541-584-2214, fax 541-584-2326
Brooks Tree Farm	503-393-6300, fax 503-393-0827
Mineral Springs Ornamentals	503-852-6129, fax 503-852-6553
Mt. Jefferson Farms	503-363-0467, fax 503-362-5248
Northwest Native Plants	503-632-7079, fax 503-632-7087
Seven Oaks Native Nursery	541-757-6620 (fax & phone)
Bosky Dell Natives	503-638-5945, fax 503-638-8047

Container Material

Northwest Native Plants	503-632-7079, fax 503-632-7087
Seven Oaks Native Nursery	541-757-6620 (fax & phone)
Bosky Dell Natives	503-638-5945, fax 503-638-8047
Watershed Gardenworks	360-423-6456

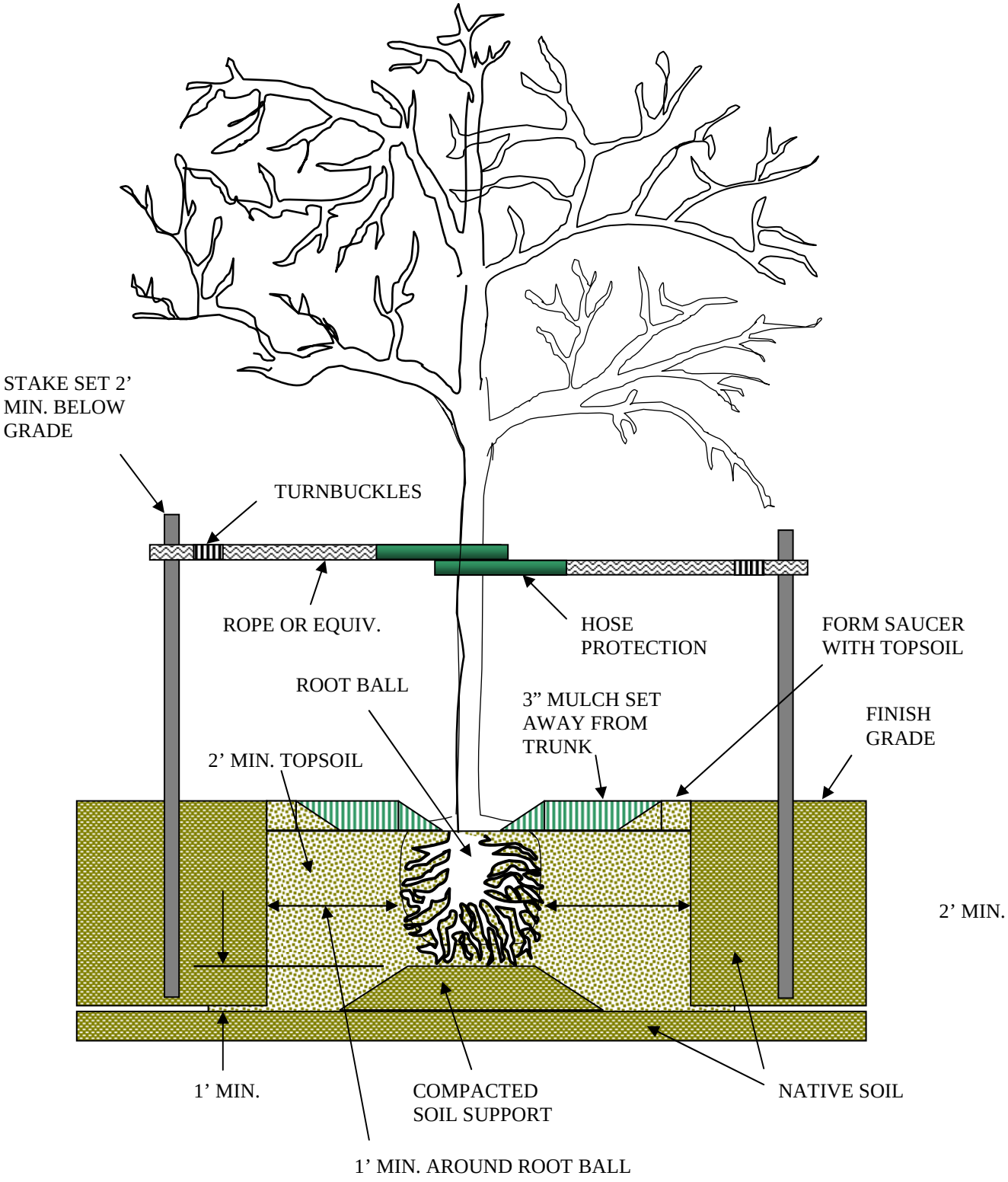
Emergent Plugs

Balance Restoration Nursery	541-942-5530 (fax & phone)
Seven Oaks Native Nursery	541-757-6620 (fax & phone)
Watershed Gardenworks	360-423-6456

Native Seed

Pacific Northwest Natives	541-928-8239
Mid-Valley Farms	541-936-6061
North American Revegetation	541-928-9095
Triangle Farms	503-873-5190
Oregon Heritage Farms	503-628-2775

Tree Planting Detail for Trees of 3″ Caliper or Larger, usually used for street trees applications. This detail is not required for smaller trees. However, all trees must be secured sufficiently at the time of planting and throughout the warranty period to assure that the tree is well established.



Parking Lot Trees

The City has included the parking lot tree list to assist designers in selection of trees most appropriate for the potentially numerous micro-climates that might exist in parking lots and often associated proximity to building walls. It is likely that most parking lots will be hot in summer months until the trees become established. The City has attempted to point out native species in the list and provide their suitability to various conditions.

Trees are listed by the scientific name of the species first, then the common name. Where applicable, names of cultivars are presented in single quote marks with the common name.

The recommended minimum clearance from the pavement provides guidance on the amount of planting space each tree needs. It is expressed as the distance from the center of the planted tree trunk to the nearest paved surface. Comments provide guidance as to best applications of the different trees and additional information that may help in tree selection. For example, some trees are well suited to landscaped areas that will receive stormwater runoff, while others may not tolerate the additional moisture from runoff, largely depending on the soil.

There are two tables. The first consists of trees that are not native to the area and the second consists of native trees.

Non-native trees

Species name	Common Name	Minimum Distance from Pavement	Comments
Abies amabilis	Silver Fir	4 feet	Conifer, evergreen. Native to Oregon Cascades.
Acer campestre	Hedge maple	2 feet	Broadleaf, deciduous.
Acer rubrum	Red maple 'Embers Red,' 'October Glory,' 'Red Sunset,' 'Gerling,' 'Autumn Flame'	3 feet	Broadleaf, deciduous. Good for stormwater facilities
Acer saccharum	Sugar Maple (Except 'Legacy')	3 feet	Broadleaf, deciduous.
Calocedrus decurrens	Incense Cedar	3 feet	Conifer, evergreen Drought tolerant
Carpinus betulus	European Hornbeam	2 feet	Broadleaf, deciduous. Shade tolerant.

Species name	Common Name	Minimum Distance from Pavement	Comments
Celtis occidentalis	Hackberry	3 feet	Broadleaf, deciduous.
Cercidiphyllum japonicum	Katsura Tree	3 feet	Broadleaf, deciduous. Prefers well-drained soils Needs summer irrigation
Cladrastis kentuckea	Yellowwood	3 feet	Broadleaf, deciduous. Prefers summer irrigation and well-drained soil.
Cornus kousa var. *chinensis*	Chinese Dogwood	3 feet	Broadleaf, deciduous. Small tree. Fruits, but is not messy. Needs summer water.
Crataegus x *lavallei*	Lavalle Hawthorn	2 feet	Broadleaf, deciduous. Fruit can be messy.
Fagus grandifolia	American Beech	4 feet	Broadleaf, deciduous.
Fagus sylvatica	European Beech	4 feet	Broadleaf, deciduous.
Fagus sylvatica	European Beech 'Roseo-marginata,' 'Tricolor'	3 feet	Broadleaf, deciduous.
Fraxinus americana	White Ash	3 feet	Broadleaf, deciduous. Needs plenty of water until established
Fraxinus excelsior	European Ash	3 feet	Broadleaf, deciduous. Needs plenty of water until established
Fraxinus pennsylvanica	Green Ash 'Marshall,' 'Patmore,' 'Summit,' 'Urbanite'	3 feet	Broadleaf, deciduous. Needs plenty of water until established
Ginkgo biloba	Ginkgo 'Shangri-la,' 'Saratoga'	3 feet	Measured as a broadleaf; deciduous. Use the male only. Female produces messy, smelly fruit.
Liquidambar styraciflua	Sweetgum	4 feet	Broadleaf, deciduous.
Liriodendron tulipifera	Tulip Tree or Tulip Poplar	4 feet	Broadleaf, deciduous.
Magnolia grandiflora	Southern Magnolia	4 feet	Broadleaf, evergreen.
Magnolia kobus	Kobus Magnolia	2 feet	Broadleaf, deciduous.
Metasequoia glyptostroboides	Dawn Redwood	4 feet	Conifer, deciduous.
Nothofagus dombeyi	South American Beech or Southern Beech	3 feet	Broadleaf, evergreen.
Nothofagus obliqua	Roble Beech	3 feet	Broadleaf, deciduous.
Nyssa sylvatica	Black Gum or Black Tupelo	3 feet	Broadleaf, deciduous. Good for stormwater

Species name	Common Name	Minimum Distance from Pavement	Comments
			facilities.
Ostrya virginiana	American Hornbeam	2 feet	Broadleaf, deciduous.
Pinus contorta	Shore Pine	3 feet	Conifer, evergreen. A smaller tree.
Pinus monticola	Western White Pine	3 feet	Conifer, evergreen.
Quercus bicolor	Swamp White Oak	3 feet	Broadleaf, deciduous. Tolerates wet soil.
Quercus coccinea	Scarlet Oak	3 feet	Broadleaf, deciduous. Intolerant of wet soil.
Quercus frainetto	Hungarian Oak 'Forest Green'	3 feet	Broadleaf, deciduous.
Quercus nigra	Water Oak	3 feet	Broadleaf, evergreen. Tolerates wet conditions.
Quercus phellos	Willow Oak	3 feet	Broadleaf, deciduous.
Quercus robur	English Oak	3 feet	Broadleaf, deciduous.
Quercus rubra	Northern Red Oak	4 feet	Broadleaf, deciduous.
Quercus velutina	Black Oak	4 feet	Broadleaf, deciduous.
Sequoia sempervirens	Coast Redwood	6 feet	Conifer, evergreen. Grows very tall.
Sequoiadendron giganteum	Giant Sequoia	8 feet	Conifer, evergreen. Trunk quickly becomes massive, needs ample space.
Sophora japonica	Japanese Pagoda Tree	3 feet	Broadleaf, deciduous.
Taxodium distichum	Bald Cypress	4 feet	Conifer, deciduous. Tolerates extremely wet conditions, but does not require it.
Umbellularia californica	California Laurel, Oregon Myrtle, Bay	4 feet	Broadleaf, evergreen. Drought tolerant.
Zelkova serrata	Sawleaf Zelkova 'Green Vase,' 'Halka,' 'Village Green'	3 feet	Broadleaf, deciduous.

Native Parking Lot Trees from the Portland Plant List

Species Name	Common Name	Minimum Distance from Pavement	Comments
Abies grandis	Grand Fir	4 feet	Conifer, evergreen. Can grow very tall.
Acer macrophyllum	Big Leaf Maple	4 feet	Broadleaf, deciduous.
Alnus rubra	Red Alder	3 feet	Broadleaf, deciduous. Moisture loving. ***Short live species.*** *
Crataegus douglasii, var. douglasii	Black Hawthorn, wetland form	3 feet	Broadleaf, deciduous. A smaller tree. Wetland form tolerates wet areas.
Fraxinus latifolia	Oregon Ash	3 feet	Broadleaf, deciduous. Tolerates wet conditions.
Pinus ponderosa, ssp. Valley	Ponderosa Pine, Valley subspecies	4 feet	Conifer, evergreen. Prefers drier conditions, but Valley subspecies is adapted to Willamette Valley climate.
Pseudotsuga menziesii	Douglas Fir	4 feet	Conifer, evergreen. Can grow very tall.
Quercus garryana	Oregon White Oak	4 feet	Broadleaf, deciduous. Drought tolerant.
Rhamnus purshiana	Cascara	3 feet	Broadleaf, deciduous. A smaller tree.
Thuja plicata	Western Red Cedar	4 feet	Conifer, evergreen. Prefers moist conditions and some shade. **Does not do well in direct sunlight, Shade tolerant**
Thuja plicata	Western Red Cedar 'Hogan'	4 feet	Conifer, evergreen. Prefers moist conditions and some shade. 'Hogan' is a narrow-growing variety.

* According to the "Western Tree Book" maximum age of a Red Alder is thought to be 100 years. Relatively speaking these trees have a life span sufficient for urban parking lot swales.

City of Grants Pass Form SIM: Simplified Approach for Stormwater Management

The city has produced this form to assist with a quick and simple approach to manage stormwater on-site.
Facilities sized with this form are presumed to comply with pollution reduction and flow control requirements.

INSTRUCTIONS	**SITE INFORMATION**	
1. Enter square footage of new or redeveloped impervious site area.	(1) Impervious Area	sf
2. Select impervious area reduction techniques from rows "a" and "b" to reduce the site's resulting stormwater management requirement. Tree credit can be calculated using the tree credit worksheet page 2.	(2) Credits	sf
3. Subtract (2) from (1) to calculate required mitigation area: (3) = (2) - (1)	(3) Required Mitigation Area	sf
4. Select desired stormwater management facilities from rows "c" - "h". In Column 1 enter the square footage of impervious area that will flow into each facility type.		
5. Multiply each impervious area from Column 1 by the corresponding sizing factor in Column 2, and enter the result in Column 3. This is the facility surface area needed to manage runoff from the impervious area.		
6. Total Column 1 (Rows "c" - "h") and enter the resulting "Impervious Area Managed" on line (6).	(6) Total Impervious Area Managed	sf
7. Subtract (6) from (3) and enter the result on line (7). When this number reaches 0, stormwater pollution reduction and flow control requirements have been met. Submit this form with the application for permit. (7) = (6) - (3)	(7) Remaining Area	sf
8. If line (7) is greater than 0 square feet, add square footage or facilities to Column 1 and recalculate, or use additional facilities from Chapter 2.0 of the Stormwater Management Manual to manage stormwater from these remaining impervious surfaces.		

	Column 1	**Column 2**	**Column 3**
Impervious Area Reduction Technique	**Impervious Area Managed = Facility Surface Area**		
a. Tree Credit (see page 2)	sf		*sf = square feet*
b. Pervious Pavement	sf		

Stormwater Management Facility*	**Impervious Area Managed**		**Sizing Factor**		**Facility Surface Area**	**Unit**
c. Infiltration Planter	_____	sf	x	0.07	= _____	sf
d. Flow-Through Planter	_____	sf	x	0.07	= _____	sf
e. Vegetated Swale	_____	sf	x	0.11	= _____	sf
f. Grassy Swale	_____	sf	x	0.14	= _____	sf
g. Vegetated Filter Strip	_____	sf	x	0.24	= _____	sf
h. Vegetated Infil. Basin	_____	sf	x	0.11	= _____	sf

i. Total Impervious Area Managed (Sum of Column 1, Rows "c" - "h") _____ sf